U.S. Department of Energy
NNSA Service Center, Oakland, California

ANNUAL SITE ENVIRONMENTAL REPORT
CALENDAR YEAR 2002

for the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH
UNIVERSITY OF CALIFORNIA, DAVIS

Submitted to:

United States Department of Energy
National Nuclear Security Administration
Service Center
1301 Clay Street
Oakland, California 94612-5208

Prepared by:

Weiss Associates
5801 Christie Avenue, Suite 600
Emeryville, California 94608-1827

August 18, 2003
Rev. 1

DOE/NNSA Oakland Operations Contract DE-AC03-96SF20686

Weiss Associates
Environmental and Geologic Services

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Approvals Page

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Michael D. Dresen, R.G., C.E.G., C.H.G.
Program Manager
Weiss Associates

Department of Energy
National Nuclear Security Administration
Service Center

National Nuclear Security Administration

AUG 1 4 2003

Subject: 2002 Site Environmental Report (SER) for the Laboratory for Energy-Related Health Research (LEHR)

Dear Sir or Madam:

The enclosed 2002 LEHR SER prepared by Weiss Associates (WA) summarizes the environmental protection activities at LEHR for calendar year 2002. SERs are prepared annually for all DOE sites conducting significant environmental activities and are distributed to relevant regulatory agencies and other interested parities.

To the best of my knowledge, the 2002 LEHR SER accurately summarizes results for the 2002 Monitoring Program and Restoration Program at LEHR. This assurance is based upon a thorough review by the NNSA Service Center and WA, and by documented quality assurance protocols applied to the monitoring and data analysis at LEHR.

The 2002 LEHR SER is also available electronically at http://www.oak.gov/Cos/Opa/Env_Rprts/Opa_EnvRptsIndex_WF.html. Please provide your comments or suggestions for future versions of the report using the enclosed reader survey form. Additionally, your questions or comments on this report may be made directly to DOE NNSA Service Center, Oakland Office by contacting Jay Tomlin of the Environmental Programs Division at 510-637-1637.

Sincerely,

Henry M. De Graca

Henry M. De Graca, Manager
Environmental Programs Division

Enclosure

CERTIFICATION OF ACCURACY FOR:

ANNUAL SITE ENVIRONMENTAL REPORT, CALENDAR YEAR 2002, LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH

I certify that the information submitted herein is true, accurate, and complete, based on my familiarity with the information and my inquiry of those individuals immediately responsible for obtaining the information.

Signature: Robert O. Devany Date: 8/18/03
Robert O. Devany, Project Manager

ANNUAL SITE ENVIRONMENTAL REPORT READER SURVEY

To Our Readers:

Each Annual Site Environmental Report publishes the results of environmental monitoring at the former Laboratory for Energy-Related Health Research (LEHR) and documents our compliance with environmental regulations. In providing this information, our goal is to give our readership—whether they are regulators, scientists, or the public—a clear accounting of the range of environmental activities we undertake, the methods we employ, and the degree of accuracy of our results.

It is important that the information we provide is easily understood, is of interest, and communicates the Department of Energy National Nuclear Security Administration's effort to protect human health and the environment. We would like to know from you, our readers, whether we are successful in these goals. Your comments are welcome.

1. Is the technical level ☐ too high? ☐ too low? ☐ uneven? ☐ just right?
2. Is the writing ☐ too concise? ☐ too verbose? ☐ uneven? ☐ just right?

	Yes	**No**
3. Do the illustrations help you understand the text better?	☐	☐
Are there enough illustrations?	☐	☐
Is the background information sufficient?	☐	☐
4. Are the methodologies being described understandable?	☐	☐
Interesting?	☐	☐
5. Are the data tables of interest?	☐	☐
Do they provide sufficient information?	☐	☐

Other comments:

____

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A business reply envelope has been attached for returning these surveys to Jay Tomlin, DOE/NNSA, 1301 Clay Street, 700N, Oakland, CA 94612-5208.

OPTIONAL

Name: ______________________ Occupation ______________________

Address: ____

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TABLES

FIGURES

APPENDIX

ACRONYMS AND ABBREVIATIONS

BEI	Bechtel Environmental Inc.
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DOE	United States Department of Energy
EPA	United States Environmental Protection Agency
HSU	hydrostratigraphic unit
ID	identification (number)
km	kilometer
LEHR	Laboratory for Energy-Related Health Research
m	meters
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
mrem/yr	millirem per year
MSDS	Material Safety Data Sheet
mSv	milliSievert
N/A	not applicable
NNSA	National Nuclear Security Administration
No.	number
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
pCi/g	picoCuries per gram
pCi/l	picoCuries per liter
PCD	Putah Creek Downstream
PCU	Putah Creek Upstream
PM_{10}	particulate matter with aerodynamic size less than or equal to 10 micrometers
PRG	preliminary remediation goal
RBAS	Risk-based action standard
rem	roentgen equivalent man

SARA	Superfund Amendments and Reauthorization Act
STPO	waste water (sewage) treatment plant outfall
UC Davis	University of California, Davis
WA	Weiss Associates
µCi/ml	microCurie per milliliter
µg/l	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter

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EXECUTIVE SUMMARY

This Annual Site Environmental Report for the Laboratory for Energy-Related Health Research (LEHR) (the Site) at the University of California, Davis (UC Davis) summarizes the United States Department of Energy (DOE), National Nuclear Security Administration's (NNSA's) environmental performance at the Site in 2002, including environmental compliance; environmental monitoring data for air, soil, ground water, surface water, storm water and ambient radiation; and environmental management programs. DOE operation of LEHR as a research facility ceased in 1989 after three decades of research on the health effects of low-level radiation exposure (primarily strontium-90 and radium-226) on human health using beagle dogs as research subjects. Contamination from prior site use, including research activities, resulted in the addition of the Site to the National Priorities List in 1994. In 1997, DOE and UC Davis reached an agreement on the responsibilities for site clean up. During Calendar Year 2002, DOE/NNSA continued environmental remediation and restoration activities at the Site in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act.

Progress of Site Environmental Restoration

DOE/NNSA site restoration activities are conducted in accordance with a 1999 Federal Facility Agreement entered into by DOE and the United States Environmental Protection Agency (EPA), California Department of Toxic Substances Control, California Department of Health Services and the Central Valley Regional Water Quality Control Board. Under the Federal Facility Agreement, DOE is responsible for remediation of site facilities, including the radium-226 and strontium-90 leach fields and tanks, DOE Disposal Box, on-site domestic septic tanks and associated systems, DOE disposal trenches, and the former Dog Pens (Figure 1-2). Under an Administrative Order on Consent with the EPA, UC Davis is responsible for remediation of three landfills, disposal trenches located south and east of the Landfill No. 2, 49 waste holes, an old waste water treatment plant, ground water impacted at the Site, and surface and storm water runoff impacted by UC Davis (Figure 1-2).

DOE/NNSA activities at the Site in 2002 consisted primarily of a removal action at two of the former domestic septic tanks and system areas, a data gaps investigation at the DOE Disposal Box, and shipment for disposal of low-level radioactive waste generated during prior remediation activities. Ground water monitoring was performed to meet regulatory and program requirements. Primary DOE/NNSA activities in 2002 included:

- **Domestic Septic Systems Removal Action:** Following a 2001 removal action at the domestic septic systems, samples collected at Domestic Septic Systems 3 and 6 indicated elevated mercury levels, and radium-226 and strontium-90 levels were above Site background in the Domestic Septic System 3 area. An

Action Memorandum for a Change in Scope of Response at Domestic Septic Systems 3 and 6 (WA, 2002a) was developed and approved, and further remedial action was completed in 2002 to remove the remaining contamination. This removal action was the last removal action planned for the site.

- DOE Disposal Box Data Evaluation: In 1996, confirmation samples were collected at the DOE Disposal Box following a removal action performed by Pacific Northwest National Laboratory (DOE, 1996). The original confirmation sampling plan design was not statistically based and the confirmation samples were not analyzed for all potential constituents of concern, resulting in data gaps. During 2002, ten additional soil samples (plus one field duplicate) were collected from the area to address the data gaps. All radionuclide concentrations were below their respective risk-based action standard values with the exception of one thorium-234 sample, which was detected above the risk-based action standard values and the site background. The DOE Disposal Box data gaps and designated-level sample data are evaluated in detail in the Draft DOE Areas Remedial Investigation Report (WA, 2003a).
- **Waste Disposal:** Approximately 39,360 cubic feet of low-level radioactive waste generated from the Radium and Strontium Treatment Systems; Domestic Septic System Numbers 1, 5 and 6; and the Western Dog Pens removal actions were shipped for off-site disposal at the Nevada Test Site and Hanford. Legacy radioactive sources and standards from research operations at LEHR were shipped to Diversified Scientific Services, Inc of Tennessee for the treatment and disposal.
- **Remedial Investigation Report:** In March of 2002 a Draft Remedial Investigation Report was submitted to the EPA, Central Valley Regional Water Quality Control Board, Department of Health Services Radiologic Health Branch and the Department of Toxic Substances Control. Approval of the final report is expected in 2003. The Remedial Investigation Report characterizes the current nature and distribution of contamination at the Site.
- **Draft Human Health and Ecological Risk Assessment:** DOE/NNSA provided data to UC Davis for inclusion in the Draft Human Health and Ecological Risk Assessment planned for submittal to regulatory agencies in August 2003. The Risk Assessment findings will be used to evaluate and select the final remedies for the Site.

Overview of 2002 Water Environmental Monitoring Results

The UC Davis water monitoring program for 2002 included:

- Remedial Investigation Water Monitoring Program; and
- Interim Remedial Action Monitoring Program, including:
  - Interim Remedial Action Monitoring; and,
  - the Land Treatment Pilot Study Monitoring.

The results of the 2002 ground water monitoring were consistent with previous years with the exception of chloromethane, which was not previously detected, and was found in HSU-1 monitoring well UCD1-18. The reported chloromethane was just above the contract-required detection limit.

Storm water and surface water samples collected and analyzed in 2002 were consistent with previous years, and no new trends or concerns were identified.

Overview of 2002 Air Environmental Monitoring Results

The current site air-monitoring program consists of collecting contaminant data on constituents of concern before, during and after removal actions. Gross alpha and beta monitoring was discontinued in 2001 based on data collected from 1996 through 2000, which showed no statistically significant deviation from background levels. Air monitoring for contaminants of concern was conducted in 2002 during the removal actions at two of the domestic septic systems. The results of the air-monitoring program were similar to previous years and showed that fugitive air emissions from the Site activities posed no hazard to the Site workers or the public.

Radiological Impact Assessment of the LEHR Environmental Restoration Project

The removal actions at the domestic septic systems and additional sampling to eliminate data gaps at the DOE Disposal Box were the primary DOE/NNSA environmental restoration activities at the Site in 2002. The removal of contaminated materials and soils from these areas will reduce the long-term risk of radiological exposure at the Site. The 2002 radiological air and ambient data all indicate that detected radionuclide activities were near or below natural background levels, and do not pose a risk to Site workers or the general public.

1. INTRODUCTION

This Annual Site Environmental Report describes Calendar Year 2002 United States Department of Energy (DOE), National Nuclear Security Administration's (NNSA) environmental restoration and waste management activities at the Laboratory for Energy-Related Health Research (LEHR) (the Site) at the University of California, Davis (UC Davis) (Figure 1-1). This report was prepared according to the requirements of DOE Order 231.1, Environmental Safety and Health Reporting. The purpose of this report is to summarize environmental data, confirm compliance with environmental standards and requirements, and highlight significant programs and efforts. This report describes activities conducted by DOE/NNSA during 2002 in support of the Site environmental restoration efforts, and provides information about the impact of these activities on the public and the environment. A ground, surface and storm water monitoring program performed by UC Davis includes information important to the overall environmental restoration of the Site and is briefly summarized herein. The UC Davis program discussed in this report is not required to comply with the requirements of DOE Order 231.1.

1.1 Site History

The Atomic Energy Commission first sponsored radiological studies on laboratory animals at UC Davis in the early 1950s. Initially situated on the main campus, LEHR was relocated to its present location in 1958 (Figure 1-1). Research at LEHR through the late 1980s focused on studying health effects from chronic exposure to radionuclides, primarily strontium-90 and radium-226, using beagles as research subjects. Other related research was conducted at the Site concurrent with these long-term studies. In the early 1970s, a cobalt-60 irradiator facility was constructed at the Site to study the effects of chronic exposure to gamma radiation on humans, again using beagles.

A campus landfill with two waste burial units that were used from the 1940s until the mid-1960s is located at the Site (Figure 1-2). Several low-level radioactive waste burial areas were also present at the Site, and campus and LEHR research waste was buried in these areas until 1974 in accordance with regulations in effect at the time. These radioactive burial areas have been remediated during several removal actions conducted at the Site since 1996.

In 1988, pursuant to a Memorandum of Agreement between DOE and the University of California, DOE's Office of Energy Research initiated activities to close out the research program at LEHR. In 1997, a second Memorandum of Agreement divided the responsibility for environmental remediation between DOE and UC Davis.

Under the Federal Facility Agreement effective in December 1999, DOE is responsible for remediation of the Radium-226 and Strontium-90 Treatment Systems, a waste burial area known as

DOE Disposal Box, on-site domestic septic tanks and associated leach fields and dry wells, DOE disposal trenches, and the former Dog Pens (Figure 1-2). UC Davis is responsible for remediation of three landfills, disposal trenches located south and east of Landfill No. 2, 49 waste holes (Figure 1-2), an old waste water treatment plant, ground water impacted by the Site, and surface and storm water runoff impacted by UC Davis.

DOE/NNSA activities at the Site in 2002 consisted primarily of the Domestic Septic Systems Removal Actions (Figure 1-3), shipment of waste generated during prior removal actions, and disposal of legacy radioactive source and standards from LEHR research activities.

1.1.1 Environmental Restoration

The DOE/NNSA Service Center manages the environmental restoration of the DOE-impacted areas of the site. From October 1989 through February 1990, an interim contract with UC Davis was implemented to begin site restoration. From 1990 to 1996, Battelle Environmental Management Operations managed the LEHR remediation project. In 1996, the project was transferred to Weiss Associates (WA) of Emeryville, California.

In May 1994, the United States Environmental Protection Agency (EPA) added the Site to the National Priorities List. A site Remedial Investigation and Feasibility Study work plan was developed to ensure that investigation and remediation were conducted in accordance with applicable regulatory requirements. Remedial Project Manager meetings are held every four to six weeks to evaluate the progress of remediation and identify actions needed to facilitate the process.

Primary DOE/NNSA restoration/remediation activities that have been performed at the Site include: soil and ground water characterization; building assessment; decontamination and decommissioning of above-ground structures; removal of contaminated underground tanks, trench structures, and contaminated soil; chemical and radiological risk assessment; preparation of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) documents, and waste management. In 2002, DOE/NNSA completed the last removal action planned for the Site at the Domestic Septic Systems (Figure 1-3). In early 2003, work began on radiological surveys of the Geriatrics-I building to allow its release to UC Davis for unrestricted use. Additionally, DOE/NNSA developed and submitted for regulatory review a Draft Remedial Investigation Report, which characterizes the nature and distribution of site contamination. (WA, 2003)

Health and safety, environmental protection and quality assurance components are integrated into the management of all remediation and site restoration activities conducted at the Site on behalf of DOE/NNSA.

1.2 Site Description

The Site is a 15-acre parcel owned by the Regents of the University of California. It is 1.5 miles south of the main UC Davis campus in a rural agricultural area (Figure 1-1), and is presently occupied by the UC Davis Center for Health and the Environment. Research at the Center for Health and the Environment includes toxicology, epidemiology, radiation biology and radiochemistry.

The Site facilities currently consist of 15 buildings, including a main administration and office building, two former animal hospitals, a laboratory and support buildings. Former facilities include: radioactive waste water treatment systems, an indoor/outdoor cobalt-60 irradiator, a radioactive waste burial area, and outdoor dog pens. Inactive campus landfill units and numerous inactive campus disposal sites (i.e., trenches and holes) were used to dispose low-level radioactive and chemical waste, and are being evaluated and/or remediated by UC Davis. Figure 1-2 shows areas that have potentially impacted the environment at the Site and those areas where DOE/NNSA removal actions have been completed.

1.3 Population Data

1.3.1 Site Population

Currently, the Site is used by the UC Davis Center for Health and the Environment to support ongoing research in toxicology, epidemiology, radiation biology and radiochemistry. The UC Davis Center for Health and the Environment consists of several research facilities occupied by approximately 200 university researchers and support staff. Center for Health and the Environment researchers and student assistants have varying schedules and are not all present at the Site at the same time.

In 2002, the LEHR remediation project was managed and staffed by WA and its subcontractors, and employed about three full-time workers at the Site. This number increased to approximately 10 workers when on-site remediation and waste management activities were in progress.

1.3.2 Local Population

The Site is located in a rural area in northeast Solano County just outside of Davis, California (Figure 1-1). The UC Davis campus has a student population of approximately 29,000 and employs approximately 17,000 full-time faculty and staff (UC Davis News Service, Facts and Figures: 2002-2003).

The estimated 2002 population of the city of Davis is approximately 63,300, and the estimated total population of Yolo County is about 168,700 (State of California, 2002a). The more densely populated and metropolitan Sacramento area is approximately 12 miles east of the Site. The current population of Sacramento County is about 1,268,770 (United States Census Bureau, 2001), and approximately 426,000 people live in the city of Sacramento (State of California, 2002b).

1.4 Environmental Setting

The Site is located on a relatively flat plain bordered on the south by Putah Creek. The Site is mostly open, slopes gently to the east, and has a few trees and bushes. The Site lies outside the Putah Creek 100-year floodplain.

1.4.1 Land Use

The land within a one-mile radius of the Site is owned both privately and by UC Davis. It is used for animal research, agriculture and recreation (i.e., fishing and swimming). Privately owned lands south and east of the Site are used to produce wheat, tomatoes, corn, barley and oats and include permanent residences. Private property to the south is separated from the Site by the South Fork of Putah Creek, and private property to the east is adjacent to non-LEHR, UC Davis-owned research facilities. The property immediately west, north and south of the Site (Putah Creek Reserve) is owned by UC Davis and is currently used for various types of animal, agricultural and health research.

1.4.2 Hydrogeology

Unconsolidated Pliocene and Pleistocene sedimentary deposits are the major ground water sources for public and private water supplies in the Sacramento Valley (California Department of Water Resources, 1978), in which the Site is located. Both unconfined and confined fresh water aquifers are present in the uppermost 3,000 feet of the valley subsurface. Ground water generally flows from the valley sides toward the valley axis. In the site vicinity, regional ground water generally flows east from the Coast Ranges toward the Sacramento River (Dames & Moore, 1993).

At various depths beneath the valley floor, saline water is present as a result of entrapment during the deposition of sediments in a marine environment. The depth to the base of fresh water in the Sacramento Valley varies from 400 feet to over 3,000 feet, and is 2,600 feet to 3,100 feet below ground surface in the Davis area (California Department of Oil and Gas, 1982).

Previous investigations identified five hydrostratigraphic units (HSUs) beneath the Site (Dames & Moore, 1999b). These include the vadose (unsaturated) zone and HSUs 1 through 4. The vadose zone extends from the ground surface to the top of ground water, which has historically ranged from 15 feet to 55 feet below ground surface. The vadose zone consists primarily of unsaturated clay and silt with lesser amounts of interbedded sand and gravel. HSU-1 extends from the bottom of the vadose zone to depths of approximately 76 feet to 88 feet below ground surface. This unit is lithologically similar to the vadose zone and consists primarily of silt and clay, with lesser amounts of sand and gravel. HSU-2 extends from the bottom of HSU-1 to depths of approximately 114 feet to 130 feet below ground surface. This unit is composed primarily of sand in the upper portion of the unit and gravel in the middle to lower portions. HSU-3, investigated in off-site areas, extends from the bottom of HSU-2 to a depth of about 250 feet below ground surface and is approximately 120 feet thick. The unit consists primarily of relatively fine-grained sediments varying from very fine-grained sandy silt to clayey silt and silty clay. HSU-4, also investigated in off-site areas, extends from the bottom of HSU-3 to a depth of about 280 feet below ground surface and is approximately 32 feet thick. This unit consists of coarse sand and gravel. Beneath HSU-4, a sharp contact with a bluish, dark gray silt was encountered 282 feet below ground surface in wells UCD4-41 and UCD4-43 (Figure 3-1). The bottom of this unit has not been penetrated in any of the site borings (Dames & Moore, 1999b).

The uppermost distinct aquifer beneath the Site consists of two HSUs (HSU-1 and HSU-2) based on the stratigraphy of the sediments at the Site and the associated ground water flow and contaminant migration characteristics (Dames & Moore, 1994). Well drillers' logs indicate that a 90-foot-thick clay unit separates HSU-2 from a second aquifer below (Dames & Moore, 1994).

Irrigation water, rainfall and Putah Creek recharge ground water in the Site vicinity (Dames & Moore, 1997). The main component of ground water recharge, however, has been identified as irrigation water infiltration (WA, 1998a). Ground water pumping associated with agriculture is responsible for the great majority of ground water withdrawal. In addition, UC Davis extracts ground water from HSU-2 as part of its interim remedial action.

Generally, there is a 20 to 30-foot seasonal fluctuation in the depth-to-ground water beneath the Site caused predominantly by the lack of surface recharge and nearby agricultural pumping in the summer. Vertical gradients vary both temporally and spatially. The magnitude of the vertical gradient is greatest when ground water elevations are rising or falling sharply. Short-term activities such as local agricultural pumping can produce downward vertical gradients during periods of an otherwise rising water table.

The HSU-1 lateral gradient across the Site typically ranges from 0.01 foot/foot to 0.04 foot/foot, and the direction of ground water flow is predominantly northeast. Representative values of HSU-1 horizontal hydraulic conductivity are between 1×10^{-4} and 1×10^{-7} centimeters per second (Dames & Moore, 1999b). The lateral gradient across the Site within HSU-2 typically ranges from 0.005 foot/foot to 0.015 foot/foot. The direction of flow appears to be predominantly northeast, although it can occasionally be east-southeast. Based on pumping tests, hydraulic conductivity in HSU-2 ranges from 0.26 centimeters per second to 0.43 centimeters per second (Dames & Moore 1997).

Ground water in HSU-1, HSU-2 and HSU-4 has been impacted by site activities. Based on investigations to date (WA, 1997a and WA, 1999a), significant ground water impacts appear to be associated only with the UC Davis disposal areas.

1.4.3 Water Supply and Quality Ground water in the site vicinity is used for agricultural and domestic supply. Regional ground water quality has been impacted by nitrates, probably from agricultural sources, and by hexavalent chromium, probably from natural sources.

Local ground water is recharged by streams and rivers, and infiltration from precipitation and irrigation. At the Site, recharge rates are highest immediately after precipitation events. Within a day after a heavy precipitation event, continuous water level measuring equipment located in monitoring wells near the creek show a significant increase (DOE, 1996).

1.4.4 Sanitary Sewer Systems

The Site discharges its sanitary wastewater to the UC Davis Waste water Treatment Plant. UC Davis operates the plant under the conditions specified in its National Pollutant Discharge Elimination System permit, granted by the Central Valley Regional Water Quality Control Board under agreement with the EPA.

1.4.5 Storm Drainage System

Storm water runoff at the Site is collected in an underground drainage system. Storm water from the paved area in the western part of the Site and around the southern buildings in the western area is collected in a storm water drainage system. This system drains to the site storm water lift station (LS-1 on Figure 3-1), and then to an outfall along the west side of Old Davis Road. Storm water in the northwestern area of the Site drains into a ditch along Old Davis Road. Storm water in the eastern and non-paved southern portions of the Site percolates into the ground, except for a section of the former Cobalt-60 Field where dog pens were once located, and where drainage is connected to the sanitary sewer. Water ponds in some areas of the site during and after heavy rains.

1.4.6 Biological Resources

A number of sensitive biological resources were identified in an Ecological Scoping Assessment (WA, 1997b) as potentially occurring in the vicinity of the site. These species include the Giant Garter Snake, the Northern Harrier, the Coopers Hawk, the California Horned Lark, the Great Egret, the Burrowing Owl and the Valley Elderberry Longhorn Beetle, which lives in elderberry bushes. Although elderberry bushes are present at the Site, a focussed biosurvey (IT Corp, 1998) found no sensitive species actually present on site and concluded that the on-site elderberry bushes are not currently hosting the Valley Elderberry Longhorn Beetle.

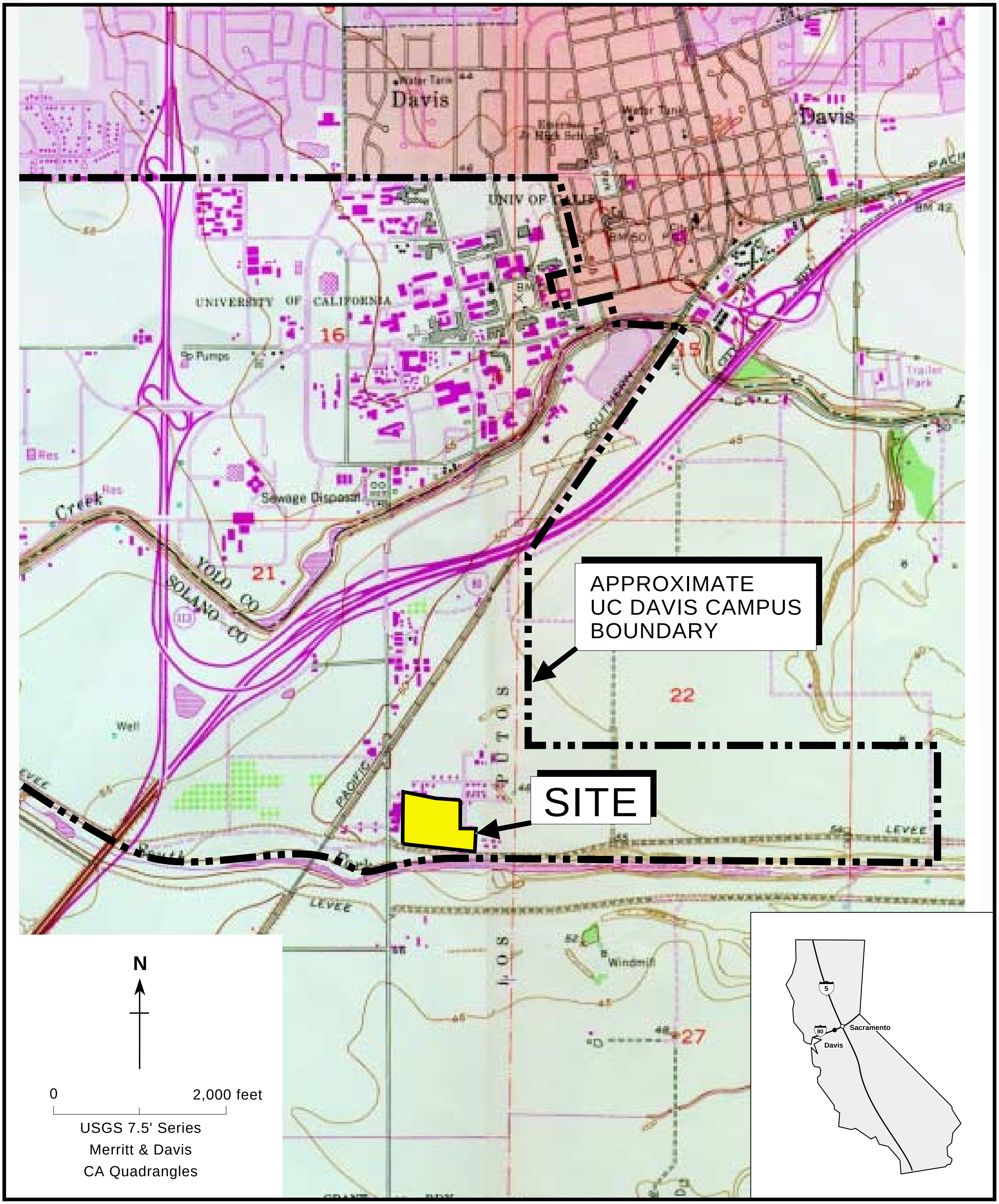

Figure 1-1. Location of the LEHR Site, UC Davis, California

Weiss Associates

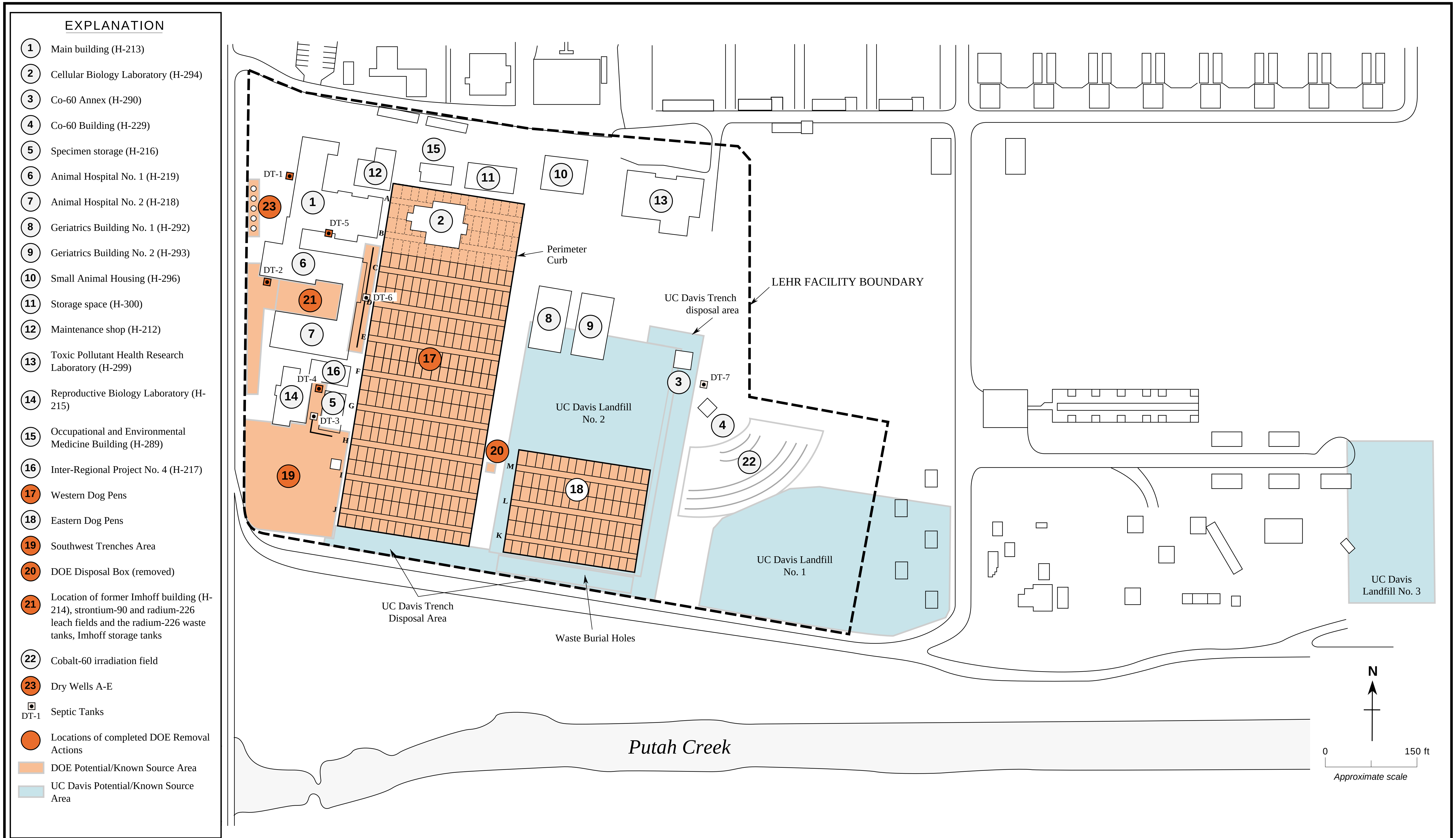

Figure 1-2. Site Features and Areas of Potentially Known Contamination Source Areas

Weiss Associates

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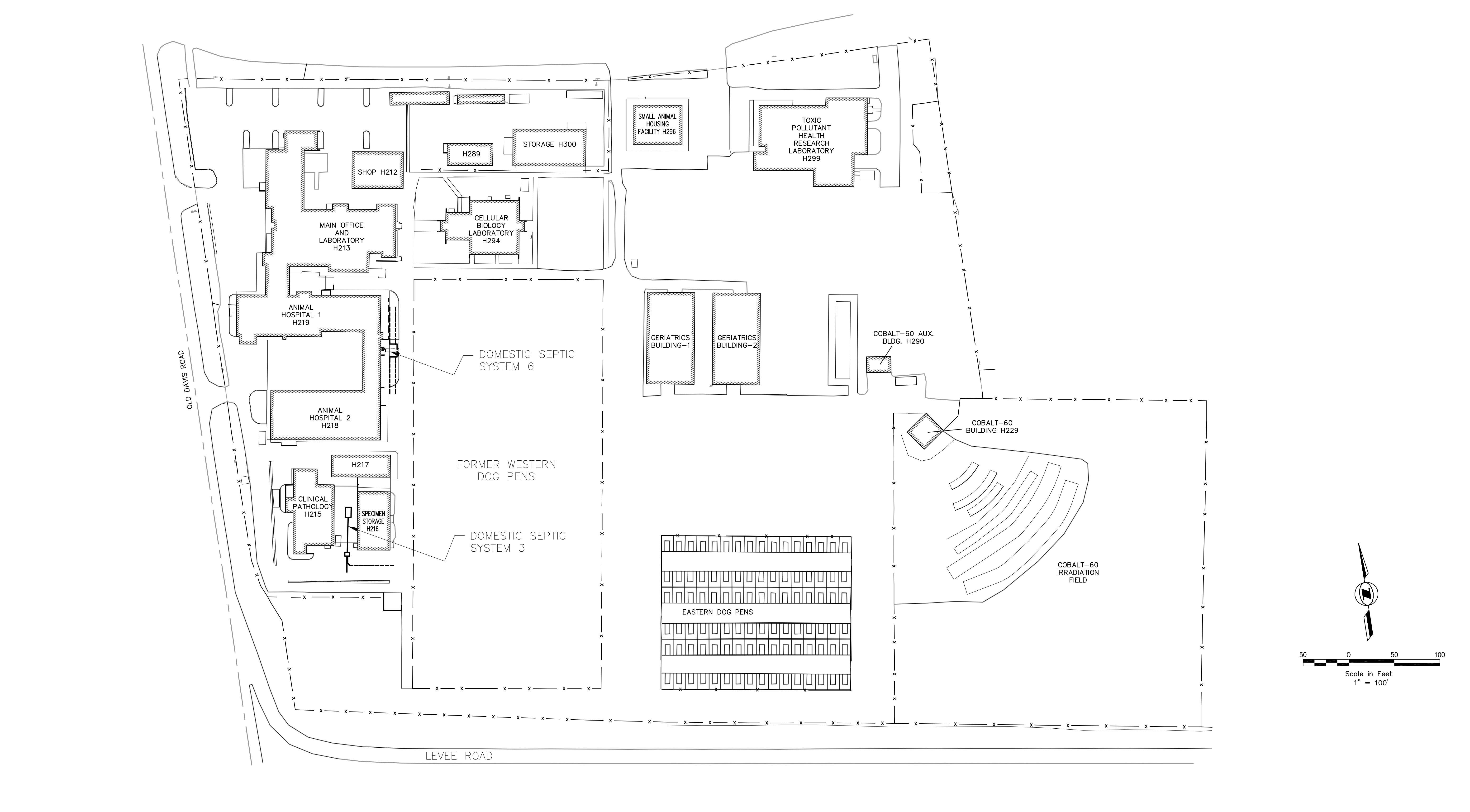

Figure 1-3. Locations of Domestic Septic Systems 3 and 6 and LEHR Facility Buildings

WEISS ASSOCIATES

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2. COMPLIANCE SUMMARY

This section summarizes the LEHR site's environmental regulatory compliance status during the environmental restoration and waste management activities conducted in Calendar Year 2002. No violations, fines or penalties were issued for the Site in 2002.

2.1 Environmental Restoration and Waste Management

Environmental restoration and waste management activities at LEHR are conducted in compliance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) and the National Contingency Plan, and include compliance with applicable or relevant and appropriate requirements and DOE Orders, as described below.

2.1.1 Comprehensive Environmental Response, Compensation and Liability Act as Amended by the Superfund Amendments and Reauthorization Act

In 1995, a streamlined remediation process was initiated at the Site using the CERCLA non-time critical removal action approach. This approach enables expedited response to contamination problems without requiring the time-consuming investigations and preparation of lengthy documents required otherwise. The removal action approach facilitates integration of clean up and data evaluation activities.

An investigation conducted at the Domestic Septic Systems (Figure 1-3) after the completion of a removal action in 2001 indicated the need to remove additional soil due to residual mercury contamination in the area. A work plan and an amendment to an Action Memorandum for additional removal action work were completed in 2002 and the removal action was conducted in the summer of 2002. Additional confirmation sampling was also conducted at the DOE Disposal Box (Figure 1-2). With the completion of the Domestic Septic Systems removal actions, DOE/NNSA has finished all removal actions planned for the LEHR site.

In March 2002, a Draft Remedial Investigation Report for the DOE Areas of the LEHR site was submitted to the regulatory agencies: the EPA, Central Valley Regional Water Quality Control Board Department of Health Services Radiologic Health Branch and the Department of Toxic Substances Control. Approval of the Final Remedial Investigation Report is expected in 2003. The DOE Remedial Investigation Report compares the current levels of contamination at the Site to the cleanup goals and evaluates the success of the remedial approaches in meeting those goals.

In addition to submittal of the Draft DOE Areas Remedial Investigation Report for regulatory review and comment, DOE/NNSA provided data to UC Davis for inclusion in the Draft Human Health and Ecological Risk Assessment planned for submittal to regulatory agencies in August 2003. The Risk Assessment will support the evaluation and selection of the final remedy for the Site.

2.1.2 Resource Conservation and Recovery Act

No hazardous waste subject to regulation under the Resource Conservation and Recovery Act was generated or shipped for disposal in 2002.

2.1.3 Federal Facilities Compliance Act

The Federal Facilities Compliance Act amends the Solid Waste Disposal Act and states that all federal agencies are subject to all substantive and procedural requirements of federal, state, and local solid and hazardous waste laws in the same manner as any private party. The act requires that a site treatment plan be prepared for each DOE site that generates or stores mixed radioactive waste. A final site treatment plan for LEHR was approved and issued in October 1995. No revisions have been made to this plan. The Site continues to be in compliance with the Federal Facilities Compliance Act.

2.1.4 National Environmental Policy Act

Consistent with DOE policy and guidance, environmental considerations for proposed removal actions and alternatives are evaluated during the Engineering Evaluation/Cost Analysis process, allowing integration of National Environmental Policy Act requirements with the CERCLA process, thereby eliminating the need for a separate National Environmental Policy Act analysis and streamlining the clean up process.

An Engineering Evaluation/Cost Analysis for the Southwest Trenches, Radium-226/Strontium-90 Treatment Systems and Domestic Septic Systems areas was completed in early 1998 (WA, 1998b) and included an evaluation of the environmental impacts associated with the Domestic Septic Systems removal actions. Additional removal actions were deemed necessary in the area and an Action Memorandum approving additional removal actions at Domestic Septic Systems 3 and 6 (Figure 1-3) was issued in 2002. No significant impacts were associated with the implementation of additional removal actions at Domestic Septic Systems 3 and 6.

Shipments of low-level radioactive sources and standards completed in 2002 was categorically excluded from National Environmental Policy Act Requirements, under 10 Code of Federal Regulations (CFR) 1021.410(b)(2).

2.1.5 Toxic Substances Control Act

Concern over the toxicity and persistence in the environment of polychlorinated biphenyls led Congress in 1976 to enact Section 6(e) of the Toxic Substances Control Act that included among other things, prohibitions on the manufacture, processing, and distribution in commerce of polychlorinated biphenyls. The Toxic Substances Control Act legislates management of polychlorinated biphenyls from manufacture to disposal. In 2002, a small volume of polychlorinated biphenyl-containing light ballasts were managed at the LEHR in accordance with regulatory requirements. The waste was removed from the Site for disposal at a permitted hazardous waste disposal facility.

2.1.6 Federal Insecticide, Fungicide and Rodenticide Act

The EPA, under the Federal Insecticide, Fungicide and Rodenticide Act, regulates the sales, distribution, and use of pesticides by requiring their registration. Registration includes approval by the EPA of the pesticide's label, which must give detailed instructions for its safe use. The EPA must classify each pesticide as either "general use," "restricted use," or both. Registered general use herbicides were applied at the Site in 2002 by the UC Davis Agricultural Services Department to control weeds. The herbicides were used in accordance with the safe use instructions and in compliance with UC Davis campus requirements, and local, state and federal laws.

2.2 Radiation Protection

All activities at the Site are conducted in compliance with Title 10 of the Code of Federal Regulations Part 835, Occupational Radiation Protection, and applicable DOE Orders, as discussed below.

2.2.1 DOE Order 5400.5, Radiation Protection of the Public and the Environment

The Report on the Radiation Protection of the Public and the Environment (WA, 2001g) was developed in 2001. The purpose of this report was to evaluate LEHR operations and document their compliance with DOE Order 5400.5, Radiation Protection of the Public and the Environment. LEHR operations continued to be in compliance with DOE Order 5400.5 in 2002.

2.2.2 DOE Order 5400.1, Environmental Protection Program

In 2001, an Environmental Protection Program (WA, 2001k) was developed which defines environmental protection activities and monitoring conducted at LEHR, including radiological controls and monitoring requirements. This program complies with DOE Order 5400.1, Environmental Protection Program. Activities conducted at LEHR in 2002 were in compliance with DOE Order 5400.1.

2.2.3 Atomic Energy Act of 1954, as Amended

Under the Atomic Energy Act of 1954, as amended, DOE has the responsibility of controlling the activities of its contractors and operations in a manner that protects the public and the environment from radiation hazards associated with its operations.

All work at LEHR is performed in compliance with the LEHR Radiation Protection Plan (WA, 1999b) and the As-Low-As-Reasonably-Achievable Plan (WA, 2001a) which comply with Title 10 of the Code of Federal Regulations Part 835. The Radiation Protection Plan and As-Low-As-Reasonably-Achievable Plan require that all work performed at LEHR be conducted in a manner that protects the public and the environment from radiological hazards.

In addition to the Radiation Protection Plan and the As-Low-As-Reasonably-Achievable Plan, the LEHR Quality Assurance Project Plan (WA, 2000a) requires that environmental monitoring aspects of all operations and activities at LEHR be addressed in the work plans developed for specific activities. All activities at LEHR complied with the Radiation Protection Plan, the As-Low-As-Reasonably-Achievable Plan, and the LEHR Quality Assurance Project Plan in 2002.

2.2.4 DOE Order 435.1, Radioactive Waste Management

A comprehensive Radioactive Waste Management Basis (WA, 2001b) and Radioactive Waste Management Plan (WA, 2001c) were developed and approved in 2001, and at that time existing standard operating procedures for waste management were updated to meet the requirements of DOE Order 435.1. All waste management activities in 2002 were carried out in compliance with these documents and were conducted in a manner that protects the public, the workers and the environment from radiological hazards.

2.3 Air Quality and Protection

2.3.1 Clean Air Act

Under the Clean Air Act, the EPA defined six criteria pollutants: carbon monoxide, nitrogen dioxide, lead, ozone, particulate matter, and sulfur dioxide, and set National Ambient Air Quality Standards for these pollutants. Of these, the only air pollutant emitted at the Site is particulate matter with aerodynamic size less than or equal to 10 micrometers (PM_{10}) generated during soil excavation activities. The Site is not a major source of air emissions.

Since the potential exists for soil and associated contamination to become airborne during sampling and excavation activities, verification of site compliance with the Clean Air Act is accomplished through air monitoring during these activities. Prior to the start of each phase of a project, an analysis is performed to evaluate air monitoring requirements and determine controls necessary to reduce any potential air emissions. Monitoring data are collected before, during and after the activity to verify that Clean Air Act requirements are met. The Site was in compliance with all Clean Air Act requirements in 2002 as administered by the Yolo-Solano Air Quality Management District.

Additionally, ambient air monitoring has been conducted since 1995, and computer simulations indicate that surface soil contamination does not impact air quality at the Site.

2.3.2 National Emission Standards for Hazardous Air Pollutants

Subpart H of 40 Code of Federal Regulations Part 61 protects the public and the environment from the hazards of radionuclide emissions, other than radon, from DOE facilities. It sets a limit on the emission of radionuclides that ensures that no member of the public in any year receives an effective dose equivalent of more than 10 millirem per year (mrem/yr).

The National Emission Standards for Hazardous Air Pollutants requirements primarily target point source/stack emissions. There are currently no point sources of radionuclide emissions at the Site. However, a Memorandum of Understanding between DOE and the EPA (DOE, 1995) applies the point source criteria to potential diffuse area sources at the Site.

The 2002 estimated dose to the public from the Site's diffuse area sources was calculated using surface soil radioactive contamination concentrations and assuming that dust generated during excavation activities and re-entrainment and dispersion of surface soil dust were the potential sources of emissions. The analysis of potential diffuse airborne radiological effluent sources at the Site is included in the 2002 Calendar Year Radionuclide Air Emission Annual Report (under Subpart H of Title 40 Code of Federal Regulations Part 61) (WA, 2001j). Fugitive emissions modeling indicated that the maximum annual credible dose equivalent to a member of the public from residual site contamination was 3.16×10^{-5} mrem/yr for an off-site exposure, and 3.8×10^{-4} mrem/yr for an on-site exposure, far below the 10 mrem/yr effective dose equivalent limit. This analysis is discussed in more detail in Section 4 of this report.

2.4 Water Quality and Protection

2.4.1 Clean Water Act

As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The Site discharges its sanitary waste to the UC Davis Waste Water Treatment Plant, which is subject to the conditions in National Pollutant Discharge Elimination System Permit CA0077895, issued to UC Davis, and Waste Discharge Requirement Order No. 92-040, granted by the Central Valley Regional Water Quality Control Board. No waste water, other than sanitary waste, was discharged from LEHR to the waste water treatment plan in 2002.

Under the Clean Water Act, EPA also controls polluted storm water runoff. In California, this function is delegated to the California Regional Water Quality Control Board, under state-wide National Pollutant Discharge Elimination System General Permits for Storm Water Discharges Associated with Industrial and Construction Activities. A storm water sampling program described in the Revised Field Sampling Plan (Dames & Moore, 1998a) is implemented at the Site and meets the state General Permit requirements. Best management practices are also used at the Site to mitigate any potential contamination in storm water runoff.

Under the Revised Field Sampling Plan (Dames & Moore, 1998a), storm water samples are usually collected twice a year, once near the beginning of the rainy season after the first significant storm of the season and once near the end of the season. Surface water samples are also collected and analyzed in accordance with the Revised Field Sampling Plan. Details of the sampling and analyses are the provided in Draft 2002 Comprehensive Annual Water Monitoring Report (Brown and Caldwell, 2003) and are summarized herein in Section 3.

2.4.2 Drinking Water Requirements

Under the Safe Drinking Water Act, EPA sets standards to protect drinking water quality and drinking water sources, including rivers, lakes, reservoirs, springs, and ground water wells. The California Porter-Cologne Water Quality Act authorizes the State Water Quality Board and Regional Water Quality Control Boards to coordinate and control water quality in the state. The regional boards establish and enforce water quality standards for both surface and ground water by issuing permits for discharges of waste water into state water bodies. The Safe Drinking Water and Toxics Enforcement Act prohibits discharge or release of chemicals known to the State of California to cause cancer or reproductive toxicity into water, or onto or into land where such chemical passes or probably will pass into any source of drinking water.

Historically, contaminated liquid waste was discharged from DOE research activities to the Imhoff Treatment Facility, the Domestic Septic Tanks and the Radium-226 Septic System and associated leach fields, which resulted in hazardous releases to site soils. These structures and associated contaminated soils have been removed and have either been shipped off site for disposal or are awaiting shipment. Current DOE/NNSA activities at LEHR do not discharge contaminants to any drinking water sources.

According to a Memorandum of Agreement between UC Davis and DOE (DOE, 1997a), potential impacts to ground water from past site activities are to be addressed by UC Davis. UC Davis is conducting a ground water interim remedial action. Quarterly ground water and surface water monitoring has been conducted since November 1990. Monitoring activities conducted in 2002 are summarized in Section 4.

2.5 Other Environmental Statutes

2.5.1 Endangered Species Act

In 1997, an Ecological Scoping Assessment (WA, 1997b) was conducted to support the Draft Final Determination of Risk-Based Action Standards for DOE Areas (WA, 1997c). The Ecological Scoping Assessment identified special status species that have a high potential to exist in or near Putah Creek, including two plant species, five invertebrates, nineteen birds, two reptiles, one amphibian and four mammals. These species and other potential receptors of concern are discussed in more detail in the Ecological Scoping Assessment. These species are considered during planning of remedial activities, so that any potential impact to them is eliminated or mitigated.

Habitat for the Valley Elderberry Longhorn Beetle, a threatened species under the Endangered Species Act, was identified in the Western Dog Pens, Eastern Dog Pens and the former Cobalt-60 Field. The LEHR staff are trained to recognize the habitat of this threatened beetle species and are required to protect the habitat from any interference or damage. No habitat modifications or adverse effects on the species resulted from the 2002 removal action activities.

2.5.2 National Historic Preservation Act

All areas affected by remediation activities in 2002 involved existing structures located on previously graded and developed land. An archeological evaluation was conducted during the Phase II Soil and Ground Water Characterization of the Site (DOE, 1992a). No evidence of cultural resources, historical or archeologically sensitive areas was encountered in 2002.

2.5.3 Migratory Bird Treaty

The Migratory Bird Treaty Act governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts and nests. No activities resulting in taking of any migratory birds, their eggs, parts or nests occurred at the Site in 2002.

2.6 Executive Orders

2.6.1 Executive Order 13148, "Greening the Government Through Leadership in Environmental Management"

Executive Order 13148 requires compliance with the Emergency Planning and Community Right-to-Know Act, also known as the Superfund Amendment and Reauthorization Act (SARA) Title III. SARA Title III requires facilities to provide information on the presence of hazardous chemicals and on the releases, both accidental and routine, of such chemicals into the environment. This information is used by state and local emergency agencies, hospitals, police and fire departments, and emergency response teams in responding to chemical emergencies, and is also available to the public to inform them of chemical hazards present in their neighborhood. The toxic release inventory requirements of SARA apply to facilities which use large amounts of certain chemicals.

The amounts of chemicals stored and used at LEHR are minimal and include such items as gasoline and propane fuels, paints, thinners, and one dewar of liquid nitrogen. The storage, use, handling, and emergency response activities associated with these chemicals are covered by the following LEHR program documents which meet the Emergency Planning and Community Right-to-Know Act requirements:

- Project Health and Safety Plan (WA, 2001l), which contains a hazard communication program, including requirements for maintaining a chemical inventory and Material Safety Data Sheets;
- Contingency Plan and General Emergency Response Procedures (WA, 2001d), which cover planning, notification requirements and release notification procedures; and,
- Occurrence Reporting Plan (WA, 2000b), which addresses the release notification process.

Since only small amounts of chemicals are used at the Site, LEHR is not required to submit a toxic release inventory under Emergency Planning and Community Right-to-Know Act Section 313, Toxic Release Inventory Reporting. The Site compliance with Emergency Planning and Community Right-to-Know Act reporting requirements is summarized in Table 2-1.

Table 2-1. Status of Emergency Planning and Community Right-to-Know Act Reporting

EPCRA Section	**Description of Reporting**	**Status**
302-303	Planning Notification	Compliant
304	Extremely Hazardous Substance Release Notification	Compliant
311-312	MSDS/Chemical Inventory	Compliant
313	Toxic Release Inventory Reporting	Not Applicable

Abbreviations
EPCRA Emergency Planning and Community Right-to-Know Act
MSDS Material Safety Data Sheet

2.6.2 Executive Order 11988, "Floodplain Management"

The Site is not on a 100-year floodplain as defined by the Federal Emergency Management Agency.

2.6.3 Executive Order 11990, "Protection of Wetlands"

No portion of the Site is designated as a wetland.

2.7 Other Major Environmental Issues and Actions

No violations, compliance orders or negative audit findings were issued to LEHR in 2002.

In 2002, the Domestic Septic Systems removal action was completed in compliance with CERCLA requirements.

Waste from prior removal actions was shipped off site for disposal at sites approved by the EPA to receive CERCLA waste. Table 2-3 summarized waste shipments completed in 2002.

No new environmental programs and procedures were developed, approved, or implemented in 2002.

A compliance audit conducted in 2002 according to Title 10 Code of Federal Regulation Part 835, Radiation Protection, identified no findings.

2.8 Continuous Release Reporting

In accordance with CERCLA, non-permitted hazardous substance releases in quantities exceeding the CERCLA reportable quantity must be reported to the National Response Center. No such releases occurred at the Site in 2002.

2.9 Unplanned Releases

No unplanned releases occurred at the Site in 2002. No reports of unusual or off-normal occurrences under DOE Order 232.1 were made in 2002.

2.10 Summary of Permits

DOE/NNSA is not required to obtain any environmental permits for remediation and waste management activities conducted under CERCLA at LEHR.

Table 2-2. Waste Shipped for Off-Site Disposal in 2002

Waste Type	Contents	Origin	Volume ft^3	Disposal Site
LLRW	Soil, gavel, concrete	DSS 1 and 5	997	Envirocare of Utah
California Combined LLRW[1]	Soil	DSS 1 and 5	9	Envirocare of Utah
LLRW	Soil, debris	Radium/Strontium Area 1	2,300	Envirocare of Utah
California Combined LLRW[1]	Soil, debris	Radium/Strontium Area 2	4,400	Envirocare of Utah
LLRW	Soil, debris	Radium/Strontium Area 2	966	Envirocare of Utah
LLRW	Solidified water	Radium/Strontium Area 2	503	Envirocare of Utah
LLRW	Sludge, debris, wood and absorbed water	Radium/Strontium Area 2	456	Hanford
LLRW	Soil	DSS 6	230	Nevada Test Site
LLRW	Concrete, metal , soil	WDPs	29,500	Nevada Test Site
LLRW	Sources and standards	NA	6	DSSI

Notes

[1] California Combined LLRW is low-level radioactive waste mixed with hazardous waste as defined by California regulations in California Code of Regulations Title 22.

Abbreviations

DSS	domestic septic system
DSSI	Diversified Scientific Services, Inc. of Tennessee
ft^3	cubic feet
LLRW	low-level radioactive waste
WDPs	Western Dog Pens

3. ENVIRONMENTAL PROGRAM INFORMATION

Each year DOE monitors the air, water, and soil conditions at the Site by collecting environmental samples and evaluating relevant sample data obtained from UC Davis. This section describes the LEHR environmental monitoring program and summarizes the environmental monitoring activities conducted in 2002. The analytical results generated by this monitoring program are discussed in Sections 4, 5 and 6.

3.1 Environmental Management

LEHR environmental management is integrated into the overall management framework of site environmental restoration and waste management activities. It includes evaluation of applicable environmental requirements, incorporation of these requirements into the CERCLA process, implementation of defined environmental controls, ongoing environmental compliance monitoring, corrective action and self-assessment procedures, and an annual management audit of the overall effectiveness of the LEHR environmental restoration and waste management program. The LEHR Quality Assurance Project Plan (WA, 2000a) defines this management and program approach, and explicitly incorporates the protection of the environment into site activities.

3.2 Environmental Protection and Monitoring Programs

The LEHR environmental management system includes the following programs and documents designed to ensure environmental protection:

- Environmental Protection Program (WA, 2001f);
- Report on Radiation Protection of the Public and the Environment (WA, 2001g);
- Radiation Protection Program (WA, 1999b);
- As-Low-As-Reasonably-Achievable Program (WA, 2001a);
- Radioactive Waste Management Program and Standard Operating Procedures (WA, 2001c);
- Hazard Category Evaluation (safety basis documentation) (WA, 2001e);
- Standard Operating Procedure 42.1, Environment, Safety and Health Reporting (WA, 2001h);
- Occurrence Reporting Plan (WA, 2000b);

- National Environmental Policy Act Environmental Assessments (WA, 1998b and WA, 2001i); and,
- Revised Field Sampling Plan (Dames & Moore, 1998a) implemented by UC Davis for ground water, surface water, soil, sediment, air and biota monitoring.

3.3 Environmental Monitoring and Surveillance

The LEHR environmental monitoring program described in Section 7 of the Final Environmental Protection Program (WA, 2001f) was developed in accordance with DOE Order 5400.1. Environmental monitoring at LEHR is managed and performed by WA and its subcontractors, with the exception of ground, surface and storm water monitoring, which is currently performed by UC Davis. Environmental monitoring at LEHR is composed of two activities: effluent monitoring and environmental surveillance. Effluent monitoring involves the collection and analysis of liquid and gaseous effluent samples to characterize and quantify contaminants released to the environment. These data are used to assess the exposure of and risk to the public and to demonstrate compliance with applicable regulations. Environmental surveillance involves the collection and analysis of air, water, soil, terrestrial foodstuffs, biota, and other media on or near DOE sites, and the measurement of external radiation. These data are used to assess potential exposure to the public, evaluate impacts on the environment, and demonstrate compliance with applicable regulations. Because activities at the Site are conducted under Superfund, water, soil, and biota monitoring is integrated into the Superfund process, as discussed in the following sections.

3.3.1 Pre-Operational Monitoring

In accordance with the LEHR Environmental Protection Program (WA, 2001f), an environmental study must be conducted prior to start of any new process which has the potential for significant adverse environmental impact. The study should be not less than one year, and preferably two years before, the start of any new process to evaluate seasonal changes and be consistent with National Environmental Policy Act requirements. The study shall:

- Characterize existing physical, chemical and biological conditions that could be affected;
- Establish background levels of radioactive and chemical components;
- Characterize pertinent environmental and ecological parameters;
- Identify potential pathways for human exposure or environmental impact; and,
- Provide a basis for developing routine operational and emergency effluent monitoring and environmental surveillance programs.

Potential significant adverse environmental impacts associated with remediation activities conducted in 2002 were evaluated in an Engineering Evaluation/Cost Analysis for the Southwest

Trenches, Radium/Strontium Treatment Systems, and Domestic Septic Systems (WA, 1998b), and were reevaluated during the development of the Action Memorandum for the Change in the Scope of Response at the Domestic Septic Systems 3 and 6 (WA, 2002a). No significant adverse impacts were determined to result from these remediation activities.

3.3.2 Surface and Storm Water Monitoring

There are currently no active process-based effluent discharges from LEHR facilities to the environment which would require effluent stream monitoring. Surface and storm water run off are the only potential liquid effluent sources of contamination.

Certain storm drains on the LEHR site are directed into the UC Davis combined storm and sanitary sewer system and subsequently treated by the UC Davis Waste Water Treatment Plant. The plant operates under National Pollutant Discharge Elimination System Permit No. CA0077895, which contains the waste water discharge requirements for the facility. Environmental monitoring and surveillance of the UC Davis Waste Water Treatment Plant is conducted by UC Davis and is discussed in Sections 4.3 and 5.3 of this report.

Surface water monitoring is conducted by UC Davis in accordance with a Revised Field Sampling Plan (Dames & Moore, 1998a) developed to comply with EPA and DOE requirements for chemical and radiological analyses, respectively. Samples are collected at three locations along the South Fork of Putah Creek (Figure 3-1). The Putah Creek Upstream (PCU) monitoring point is located upstream of the LEHR site. The Putah Creek Downstream (PCD) monitoring point is located downstream of the LEHR site and UC Davis property. The waste water treatment plant outfall (STPO) monitoring station is located at the outfall of the UC Davis Waste Water Treatment Plant, which discharges into the South Fork of Putah Creek between PCU and PCD (Figure 3-1).

Surface water runoff samples are collected quarterly to coincide with ongoing LEHR project activities and are analyzed for radioactive and hazardous materials. The types of analyses are based upon those contaminants historically present at the LEHR site and are monitored as part of ongoing LEHR remediation and waste management activities.

In accordance with the Memorandum of Agreement between DOE and UC Davis (DOE, 1997a), DOE/NNSA collects storm water samples from a lift station located on the western border of the site (LS-1 on Figure 3-1), and UC Davis collects samples from the UC Davis areas of the site (LF-1 and LF-3 on Figure 3-1). The LS-1 collection point is a lift station located on the west side of the site, which pumps runoff to a ditch along the west side of Old Davis Road. All of the storm water monitoring data collected by UC Davis and DOE are included in an annual report prepared by UC Davis. In accordance with the Revised Field Sampling Plan (Dames & Moore, 1998a), sampling is conducted for two separate rainfall events: (1) the first significant storm event of the rainy season to sample runoff that may carry material that accumulated on the ground surface during the summer months; and, (2) a large storm event late in the rainy season. Storm water samples are analyzed for the following possible contaminants: selected radionuclides (tritium, carbon-14, strontium-90, radium-226), metals, hexavalent chromium, nitrate, alkalinity, other cations and anions, volatile organic compounds, chloroform, semi-volatile organic compounds, formaldehyde, pesticides, polychlorinated biphenyls, total oil and grease, suspended and dissolved solids, total organic carbon, chemical oxygen demand, and turbidity.

In 2002, UC Davis performed all surface water monitoring and monitored storm water runoff from the UC Davis areas of the site. DOE/NNSA monitored storm water runoff from the DOE areas only. The surface water monitoring results are discussed in detail in Sections 4.3 and 5.3.

3.3.3 Ground Water Monitoring

DOE and UC Davis signed a Memorandum of Agreement (DOE, 1997a) to divide responsibility for site areas of contamination according to historical site use and operation. UC Davis has assumed responsibility for ground water remediation activities because contamination of the ground water appears to be related primarily to the UC disposal areas. The primary constituents of concern in ground water are chloroform and other volatile organic compounds, chromium (primarily hexavalent chromium) and nitrate. UC Davis is currently operating an interim remedial action system to extract and treat chloroform in HSU-2 and gather data that will aid in the assessment of ground water treatment effectiveness and the need for further ground water remedial actions.

The ground water monitoring plan for the Site is defined in the Revised Field Sampling Plan (Dames & Moore, 1998a). The locations of ground water monitoring wells are shown on Figure 3-1. Twenty-three wells are monitored as part of the routine ground water monitoring program. Five of the monitoring wells (UCD1-3, 1-5, 1-6, 1-8, and 1-9) are not sampled as part of the quarterly ground water monitoring program because they are generally dry. In the event that the water table reaches the screened interval in these wells, they are included in the on-site HSU-1 water level measurements for that period. Ground water samples are collected and analyzed on either a quarterly, semi-annual or annual basis.

In 2002, UC Davis performed all site ground water monitoring. The ground water monitoring results are discussed in Section 6.

3.3.3.1 Ground Water Protection

In addition to ground water remediation conducted by UC Davis, ground water protection in 2002 was achieved through spill prevention measures implemented during site remediation and waste management activities, such as covering all storm drains near excavation activities, covering stockpiles of excavated soil and minimizing the dispersion of dust by water suppression.

3.3.4 Air Monitoring

There are currently no point sources of radionuclide or chemical emissions at LEHR. The only potential sources of air emissions are areas undergoing remediation that may generate potentially contaminated dust during construction-type activities. Under realistic conditions, airborne effluent from these sources does not require sampling for hazardous materials because there are no appreciable quantities of uncontained hazardous materials in the facilities or surface soil (Dames & Moore, 1992; BEI, 1991).

Airborne emissions of radioactive and hazardous materials from DOE-controlled facilities are subject to EPA regulations. The primary regulatory driver for air monitoring programs at DOE facilities is 40 Code of Federal Regulations Part 61, Subpart H, National Emission Standards for Hazardous Air Pollutants for Emissions of Radionuclides from DOE Facilities. Subpart H of the National Emission Standards for Hazardous Air Pollutants requirements primarily target point source/stack emissions. However, a Memorandum of Understanding between the DOE and the EPA (DOE, 1995) applies the same criteria to potential diffuse area sources that are required of point sources. The National Emission Standards for Hazardous Air Pollutants regulations require that radionuclide emissions not exceed levels that would result in an effective dose equivalent of 10 mrem/yr. Measurement of emission rates is required for all release points with the potential to release radionuclides into the air that would cause an effective dose equivalent in excess of 1% of the standard (i.e., an effective dose equivalent >0.1 mrem/yr) and all radionuclides which could contribute to >10% of the potential effective dose equivalent for a release point.

Radioactive and non-radioactive materials in air have been monitored at a number of locations at and near the Site since August 1995. The locations of the current air monitoring stations are shown in Figure 4-1. The majority of radionuclide analytical results for samples collected in 2002 are close to or below the minimum detectable activity for the laboratory analysis methods. The types of monitoring conducted and the results obtained in 2002 are discussed in Section 4.1.

3.3.5 Environmental Dosimetry

Thermoluminescent dosimeters are used to quantify the exposure of on- and off-site personnel to penetrating gamma radiation. Currently, 28 locations are monitored for penetrating radiation (Figure 4-2). Thermoluminescent dosimeters are placed near perimeter fence lines, radioactive waste storage areas and various work areas around the Site. The thermoluminescent dosimeters are analyzed quarterly, and an annual gamma radiation dose is calculated for each location. The thermoluminescent dosimeter data are normalized by subtracting site background activity from each location. The results of the ambient radiation monitoring program are discussed in Section 4.4.

3.4 Site Environmental Training

Site-specific environmental training is conducted annually to instruct project personnel on environmental policies, programs and procedures; project-specific environmental controls; pollution prevention goals; and waste minimization requirements. This training is conducted as part of the site orientation. Additional training is provided prior to any new activity that could potentially impact the environment. Daily safety meetings reinforce this training and specify the steps needed to assure adequate environmental protection during that day's activities.

Before a worker is allowed to begin hazardous site work, he or she must complete a 40-hour Occupational Safety and Health Administration Hazardous Waste Operations Training. In addition, each worker receives hazard communication training. This training ensures that the worker is aware of proper handling, usage and disposal of chemicals used on the job. It covers spill prevention and control, as well as proper storage and chemical disposal methods. Workers are also trained in radiological control methods to prevent the spread of radioactive contamination to the environment, and emergency response and reporting procedures to ensure proper response in the event of an incident.

3.5 Waste Minimization and Pollution Prevention

Site remediation activities generate hazardous and radioactive waste. The LEHR waste management program is committed to minimizing waste volumes by giving preference to source reduction, material substitution, decontamination, and recycling. Applicable waste minimization activities include:

- Avoiding the use of porous materials that cannot be decontaminated;
- Minimizing personal protective equipment waste through effective planning;
- Using real-time analyses to delineate the extent of contamination;
- Optimizing waste container utilization and recycling;
- Removing surface contamination from subsurface structures and pipes; and,
- Reusing uncontaminated soil and materials on site.

3.5.1 Waste Minimization Using Expedited Data Feedback

During the 2002 removal actions, process knowledge was used to remove contaminated material and structures from the Domestic Septic Systems areas. Expedited data feedback was used to confirm that cleanup levels were being achieved, thereby minimizing the generation of additional waste requiring off-site disposal. In order to implement expedited data feedback, an on-site radiological laboratory and a near-site mercury analytical laboratory were established to provide near real-time analytical results. The use of near real-time data facilitated the segregation of clean soil from contaminated material and avoided unnecessary off-site disposal of uncontaminated material as low-level radioactive waste.

3.5.2 Use of Innovative Packaging to Preserve Landfill Space

During 2002, LEHR continued to use soft-sided containers for radioactive and hazardous waste packaging. Soft-sided containers conform to the packaged waste, optimizing container loading by minimizing void space, which preserves valuable landfill space and reduces disposal costs. Void space in traditional packages (e.g., drums, steel boxes, etc.) is between 10% and 20% depending on the size, shape and density of the waste.

3.5.3 Reuse of Excess Electronic Equipment

Land disposal of certain electronic equipment is prohibited because of hazardous levels of metals in monitors and circuitry. A local vendor was identified by DOE/NNSA-Oakland that refurbishes computers to benefit charitable organizations and/or disassembles the equipment to reclaim metal, glass and plastic. LEHR salvage and excess computer equipment are delivered to the Alameda County Computer Resource Center in Oakland, California for reuse and/or recycling. The Alameda County Computer Resource Center is utilized by other DOE/NNSA-Oakland sites to disposition excess electronic equipment, and was verified by the LEHR project as a suitable local recycling and reuse vendor.

3.5.4 Recycling

A recycling program instituted in 2001 continued at LEHR in 2002. To the extent practicable, all paper, plastic, and cardboard waste generated by the project were recycled.

3.6 Protection of Biota

DOE Order 5400.5 and the interim DOE Technical Standard, "A Graded Approach for Evaluating Radiation Dose to Aquatic and Terrestrial Biota" (DOE, 2000) provide guidance on monitoring aquatic biota and terrestrial foodstuffs, a broad category that includes vegetation and fauna. Surveillance of terrestrial foodstuffs is required to quantify radioactive materials and chemicals, and to demonstrate that radioactive and hazardous materials are not accumulating in the environment. Currently, no sampling of terrestrial foodstuffs is planned at LEHR. A site-wide risk assessment evaluating the site ecological risks is being developed by UC Davis. Surveillance requirements will be evaluated and/or developed based on the information obtained in this risk assessment.

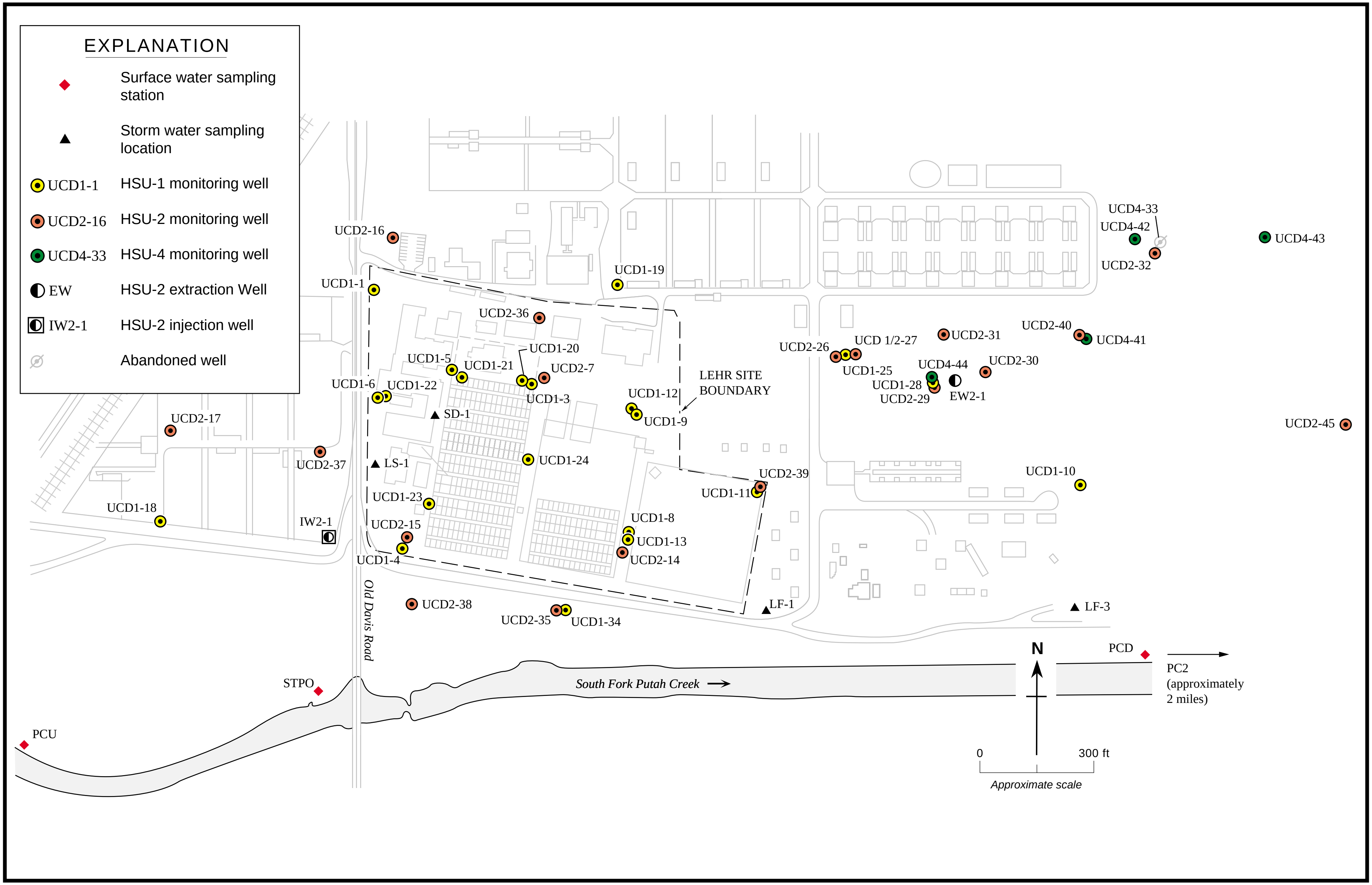

Figure 3-1. Ground Water, Storm Water and Surface Water Monitoring Locations

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4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

This section summarizes significant results and trends in radiological air, soil, and water monitoring data for 2002. The majority of radionuclide sample results for samples collected at the Site in 2002 were close to or below the minimum detectable activity for the laboratory analysis methods.

4.1 Radiological Air Monitoring

Atmospheric releases of pollutants from the Site are a potential source of human exposure. Therefore, radioactive and non-radioactive materials in air have been monitored at a number of locations at and around the Site since August 1995. The locations of the current air monitoring stations are shown in Figure 4-1.

The influence of LEHR emissions on local air pollutant concentrations is evaluated by comparing air concentrations measured at a background location to those measured at the Site. Based on historical air monitoring data and the fact that all major sources of radiation emissions had been removed from the Site prior to 2002, only radionuclides specific to site activities were monitored. The air-monitoring program included collection of air samples at three on-site stations (AM-2, AM-5 and AM-7) and one remote background station (AM-3). Station AM-7 is a mobile station and was positioned upwind of remediation activities prior to their start. In 2002, monitoring was conducted once during the Domestic Septic Systems 3 and 6 removal actions. Cesium-137, lead-210, radium-226, and strontium-90 were monitored because they were identified as soil contaminants that could become airborne during remediation activities.

4.1.1 2002 Radiological Air Monitoring Program Results

Based on the constituents of concern detected in soil at Domestic Septic Systems 3 and 6, air sampling for cesium-137, lead-210, radium-226, and strontium-90 was conducted once prior to the 2002 removal action. All radionuclide concentrations were below their respective detection limits. The average lead-210, and strontium-90 concentrations from the three on-site monitoring stations marginally exceeded the concentrations at the background monitoring station (Table 4-1). However, all of the maximum concentrations were well below their respective derived concentration guide values and did not pose any health risks to site workers or laboratory personnel at LEHR.

4.1.2 National Emission Standards for Hazardous Air Pollutants Dose Estimation Calculations

Calculations were performed to determine the estimated radiation dose from site sources to the public. During 2002, the Western Dog Pens, Eastern Dog Pens, and Domestic Septic Systems 3 and 6 were identified as potential non-point diffuse sources of radionuclide emissions generated by wind-blown, fugitive dust. Based on the surface and shallow soil sampling results from the Western and Eastern Dog Pens, surface contamination is conservatively assumed to exist across the entire area of each potential radionuclide non-point emissions source. The 2002 Domestic Septic Systems 3 and 6 removal action was the only significant change to site conditions that could have resulted in emissions different from those estimated in the Radionuclide Air Emission Annual Report for Calendar Year 2001 (WA, 2002b).

Compliance with the National Emission Standards for Hazardous Air Pollutants requirements for diffuse, non-point source emissions was assessed using the EPA atmospheric dispersion/radiation dose calculation computer code, CAP88-PC Version 1.0. This code was used to calculate the effective dose equivalent to individual receptors at various distances from the Western and Eastern Dog Pens. “Individual receptor” CAP88-PC runs were executed for each non-point source area to model the fugitive dust emission sources. For each of the four potential radionuclide emission non-point sources, a human receptor was identified in each of the north, south, east and west quadrants relative to the source.

The CAP88-PC computer code was then used to calculate the effective dose equivalent to individual receptors at various distances and from each of the potential LEHR facility radionuclide emission sources. The reported effective dose equivalent to a maximally exposed individual at the LEHR facility includes contributions from the four potential radionuclide emission non-point sources. Based on the combined non-point source exposures, the maximally exposed individual at the LEHR facility is located in the Inter-Regional Project No. 4 Building (Building H-217) (Figure 1-2). The results of the assessment are shown in Table 4-3.

Conservative radionuclide emission rates in fugitive dust were estimated using maximum soil radionuclide activities above the Western and Eastern Dog Pens backgrounds and were used to calculate the total estimated contribution to the effective dose equivalent. The total contribution to the effective dose equivalent for an on-site maximally exposed individual resulting from non-point source emissions was estimated to be 1.0×10^{-3} mrem/yr (1.0×10^{-5} milliSieverts per year), far below the 10 mrem/yr standard (Table 4-5).

The CAP88-PC computer code was also used to calculate the collective population dose as required by DOE Order 5400.5. The collective dose equivalent to Davis residents was 2.19×10^{-4} person-roentgen equivalent man per year (Table 4-5), and the effective dose equivalent for the off-site maximally exposed individual was 7.20×10^{-5} mrem/yr, as estimated by CAP88-PC. The calculated effective dose equivalent for the off-site maximally exposed individual is several orders of magnitude below the 10 mrem/yr standard, as required by Title 40 of the Code of Federal Regulations Part 61, Subpart H.

4.2 Radiological Soil Measurements

This section summarizes 2002 field activities and important soil analytical results for radiological constituents for the DOE areas at the Site. The analytical results for non-radiological compounds are discussed in Section 5.

Soil sampling for radiological analyses was performed in the Domestic Septic System 3 and the DOE Disposal Box areas (Figure 1-2) in 2002. Soil samples were shipped to a contract laboratory for the requested suite of analyses. Full descriptions of the soil sampling methods, procedures for sample preparation and shipment, requested analyses and minimum detectable activity limits, along with the associated quality assurance/quality control requirements, are contained in the relevant work plans and reports.

4.2.1 Domestic Septic System 3

A removal action was conducted at Domestic Septic System 3 in 2002. Following the removal action, a total of 42 confirmation samples (including five field duplicates) were collected from the excavation. Of the 37 confirmation samples, 30 (including three field duplicates) were analyzed for cesium-137, lead-210, radium-226 and strontium-90. One sample was analyzed for a full suite of radionuclides.

Bismuth-212, bismuth-214, cesium-137, lead-214 and thorium-234 were detected above background in sample SSD3C036, collected 5.5 feet below ground surface. Strontium-90 was detected above background in 19 of 27 samples. The maximum strontium-90 concentration, 1.6 picoCuries per gram (pCi/g), was detected in sample SSD3C056, collected 13 feet below ground surface. All radionuclide concentrations were below their respective risk-based action standard values.

A preliminary analysis of data collected in the area prior to the Domestic Septic System 3 removal action was conducted to determine if residual contamination exceeded the Regional Water Quality Control Board's designated levels which are designed to protect water quality (see Section 8, Definitions). Radium-226 was the only radiological constituent that required additional sampling to determine whether residual contamination could potentially impact ground water. One boring was drilled at the first point of perforation on the eastern Domestic Septic System 3 leach line. Samples were collected at five-foot intervals between 15 and 40 feet below ground surface. All of the radium-226 concentrations were below background.

The confirmation and designated-level sample data are evaluated in detail in the Final Domestic Septic Systems 3 and 6 Removal Actions Confirmation Report (WA, 2003b).

4.2.2 Domestic Septic Tank 5

Soil data collected from Domestic Septic Tank 5 in 2001 was analyzed to determine if it exceeded the Regional Water Quality Board's designated levels for watershed quality. The analysis identified uranium-235 as a radionuclide of potential concern. In October 2002, additional sampling was conducted at sample location SSD5C001, the sole soil sample collected from the area of Domestic Septic System No. 5. Sample SSD5C001 was collected 7 feet below ground surface and additional samples for comparison to designated levels were collected at five-foot intervals starting at 12 feet and terminating at 37 feet below ground surface.

Uranium-235/236 was measured above background in two of the samples. The maximum detected uranium-235/236 concentration, 0.0594 pCi/g, was measured in sample SSD5DL08 collected at 37 feet below ground surface. All uranium-235/236 concentrations were below the risk-based action standards of 0.15 pCi/g for uranium-235.

4.2.3 DOE Disposal Box

In 1996, confirmation samples were collected at the DOE Disposal Box following a removal action performed by Pacific Northwest National Laboratory (DOE, 1996). The original confirmation sampling plan design was not statistically based and the confirmation samples were not analyzed for all potential constituents of concern, resulting in data gaps. During 2002, ten additional soil samples (plus one field duplicate) were collected from the area to address the data gaps. The samples were analyzed for americium-241, carbon-14, plutonium-241, strontium-90, thorium-228, thorium-230, thorium-232, thorium-234, tritium, uranium-232/234, uranium-235/236, uranium-238 and unknown gamma emitters.

Americium-241, carbon-14, lead-214, plutonium-241, strontium-90, thorium-232, thorium-234 and uranium-235 were detected above background in one or more samples (Table 4-7). Plutonium-241 and americium-241 were the only two radionuclides with concentrations greater than two times the background concentration. The maximum detected plutonium-241 and americium-241 concentrations were detected in sample SSDBC019 5.4 feet below ground surface. All radionuclide concentrations were below their respective risk-based action standard values with the exception of thorium-234, which was detected above the risk-based action standard values in all ten of the samples. However, of these ten, only one thorium-234 concentration of 1.13 pCi/g, was detected above the background value of 0.78 pCi/g.

A preliminary designated-level analysis of the DOE Disposal Box area samples identified uranium-235/236 as a constituent that could potentially impact ground water. A boring was drilled at confirmation sample location SSDBC035, which had the maximum detected uranium-235/236 concentration of 0.074 pCi/g. Samples were collected at five-foot intervals starting approximately five feet below the original sample depth of 5.5 feet below ground surface. Samples were collected to 35.5 feet below ground surface. All samples contained concentrations of uranium-235/236 above the site background concentrations. The maximum detected uranium-235/236 concentration was

0.0671 picoCuries per gram at 25.5 feet below ground surface. All of the uranium-235/236 concentrations were below the risk-based action standard of 0.15 picoCuries per gram.

The DOE Disposal Box data gaps and designated-level sample data are evaluated in detail in the Draft DOE Areas Remedial Investigation Report (WA, 2003a).

4.3 Radiological Surface and Storm Water Monitoring

Quarterly surface water sampling has been conducted at the Site since 1990 for an extensive list of analytes. In 1997, in accordance with the Memorandum of Agreement, responsibility for surface water sampling was transferred to UC Davis. DOE/NNSA retained responsibility for storm water runoff sampling in the DOE areas of the site. Trends and conclusions drawn from the surface and storm water monitoring results are briefly discussed below. A detailed discussion of results, including tables summarizing the analytic data, can be found in the Draft 2002 Comprehensive Annual Water Monitoring Report (Brown and Caldwell, 2003).

4.3.1 Surface Water Monitoring

In 2002, UC Davis collected six surface water samples from three locations: PCU, STPO, and PCD (Figure 3-1). Samples were collected during only one rainfall event on November 12, 2002. Observations of sampling locations were made during periods of rain other than November 12, 2002; however sufficient water was not available to collect surface water samples. The samples that were collected were analyzed for carbon-14, radium-226, strontium-90 and tritium. None of these radionuclides were detected above the contract-required detection limits.

4.3.2 Storm Water Monitoring

All storm water sampling locations were observed during numerous storms throughout the rainy season in 2002; however, only two monitoring locations, LF-1 and LS-1, produced a discharge sufficient for sampling. LF-1 was sampled on November 9, 2002 and the sample was analyzed for carbon-14, radium-226, strontium-90 and tritium. LS-1 was also sampled on November 9, 2002 and the sample was analyzed for actinium-228, bismuth-212, bismuth-214, carbon-14, cesium-137, cobalt-60, lead-210, lead-212, lead-214, potasium-40, sodium-22, thalium-208, thorium-234, uranium-235, uranium-238, strontium-90, radium-226, gross alpha and gross beta. Of these, only gross alpha and gross beta exceeded the contract-required detection limits. The gross alpha and gross beta activities are higher than previous years due to a change in protocol to not filter the samples prior to analysis and the relatively high sediment content in the sample.

4.4 Passive Thermoluminescent Dosimeter Monitoring Program

The LEHR ambient radiation monitoring program uses thermoluminescent dosimeters to monitor gamma radiation throughout the site. The thermoluminescent dosimeters are placed near perimeter fence lines, radioactive waste storage areas and various work areas around the Site (Figure 4-2). The thermoluminescent dosimeters are collected quarterly, and an annual gamma radiation dose is calculated for each location. In 2002, thermoluminescent dosimeters and analyses were provided by Radiation Detection Company, which is certified by the National Voluntary Laboratory Accreditation Program. TLD-35, located at the equine center to the north of the Site, is used to monitor background activity.

The annual background dose near the Site measured by TLD-35 was 79 mrem/yr, which is consistent with previous years. The annual dose at the Site slightly exceeded the background at three locations, TLD-14, TLD-20 and TLD-A by 3 mrem, 1 mrem, and 5 mrem, respectively. TLD-14 and TLD-A are located at a building where legacy radioactive sources and standards were stored for part of 2002. The total dose measured at this location has historically been significantly higher than the background dose, but below the DOE limit for public exposure.

In all other locations the radiation dose was consistent with the site background. The DOE limit for exposure of members of the public as a consequence of routine DOE activities is 100 mrem/yr. Calendar Year 2002 thermoluminescent dosimeter results show that ambient radiation detected at the Site is either at background levels or well below the DOE dose limit for the general public. **Error! Reference source not found.**5 provides all gamma radiation dose data for 2002.

Table 4-1. Domestic Septic Systems 3 and 6 Removal Actions Radionuclide Air Monitoring Data Summary

Contaminant of Concern	Average Concentration[1] μCi/ml	Maximum Concentration[1] μCi/ml	Background Concentration[1,2] μCi/ml	DCG μCi/ml	Average Concentration > Background?	Maximum Concentration > DCG?
Cesium-137	2.05E-18	4.5E-17	5.19E-17	4E-10	No	No
Lead-210	2.16E-14	3.53E-14	4.37E-15	9E-13[3]	Yes	No
Radium-226	3.56E-16	5.84E-16	5.56E-16	1E-12[4]	No	No
Strontium-90	3.62E-17	4.94E-17	1.4E-18	9E-12	Yes	No

Notes

[1] All radionuclide concentrations were below the detection limit.

[2] The background concentration is the air concentration detected at the background air monitoring station, AM-3, during the Domestic Septic Systems 3 and 6 removal actions.

[3] Derived concentration guide value for lung retention class “D”.

[4] Derived concentration guide value for lung retention class “W”.

Abbreviations

DCG derived concentration guide
ND not detected
μCi/ml microCurie per milliliter

Table 4-2. Summary of On-Site Effective Dose Equivalent to Maximally Exposed Individual Resulting from Radionuclide Emissions from Each Potential Fugitive Dust Emission Non-Point Source

Receptor Location	Non-Point Source: Western Dog Pens Area (mrem/yr)[1]	Western Dog Pens Area Location[2]	Eastern Dog Pens Area (mrem/yr)[1]	Eastern Dog Pens Area Location[2]	Domestic Septic System 3 (mrem/yr)[1]	Domestic Septic System 3 Location[2]	Domestic Septic System 6 (mrem/yr)[1]	Domestic Septic System 6 Location[2]	Maximum Total Dose (mrem/yr)[3]
Specimen Storage Building (Building H-216)	2.7E-04	48 m W	5.6E-05	132 m W	3.20E-05	15 m N	1.30E-06	58 m S	3.6E-04
UC Davis Building E of LEHR Site	1.9E-05	300 m E	8.7E-06	180 m E	3.80E-07	346 m E	2.00E-07	338 m E	2.8E-05
Off-Site Receptor S of Putah Creek	1.7E-05	1,200 m S	6.3E-07	1,000 m S	3.70E-07	1173 m S	1.80E-07	1246 m S	1.8E-05
Off-Site Receptor W of LEHR Site	2.2E-05	400 m W	4.2E-06	500 m W	4.00E-07	354 m W	2.30E-07	360 m W	2.7E-05
Animal Hospital Building No. 1 (Building H-219)	2.1E-04	65 m W	3.6E-05	165 m W	1.60E-06	85 m NW	8.50E-06	31m NW	2.6E-04
Inter-Regional Project No. 4 Building (Building H-217)	3.2E-04	52 m W	4.8E-05	143 m W	7.30E-06	34 m N	1.80E-06	43 m S	**3.8E-04**
Animal Hospital Building No. 2 (Building H-218)	2.1E-04	65 m W	3.6E-05	165 m W	3.30E-06	53 m NW	2.70E-06	31 m NW	2.5E-04
Cellular Biology Laboratory (Building H-294)	2.7E-04	65 m N	4.2E-05	150 m NNE	8.20E-07	118 m NE	2.60E-06	52 m NE	3.2E-04
Clinical Pathology (H-215)	1.00E-04	99 m W	4.40E-05	150 m W	1.40E-05	24 m N	7.60E-07	61 m SW	1.6E-04
Main Office (H-213)	2.70E-04	65 m NW	3.80E-05	187 m NW	1.20E-06	110 m N	4.50E-06	43 m N	3.1E-04

Notes

1 The effective dose equivalent to the maximally exposed individual is taken as the maximum modeled dose within a 45^{o} sector in the direction and at the distance indicated in the "location" columns. For example, the dose 65 m north of the Western Dog Pens Area would be the maximum modeled dose at 65 m N, 65 m NNE and 65 m NNW.

2 The distance from an area source to a receptor is defined by CAP88-PC as the distance from the centroid of the area source to the receptor. For the LEHR facility CAP88-PC modeling, the distance from an area non-point source to a receptor is measured as the approximate distance from the centroid of the area non-point source to the centroid of the building assumed to house the receptor.

Table 4-2. Summary of On-Site Effective Dose Equivalent to Maximally Exposed Individual Resulting from Radionuclide Emissions from Each Potential Fugitive Dust Emission Non-Point Source (continued)

[3] The maximum total dose is the sum of effective dose equivalent modeled for each maximally exposed individual receptor from the four potential radionuclide fugitive dust emission non-point sources. Value in **boldface** is the maximum total dose for the site-wide maximally exposed individual.

Abbreviations

E	east
m	meters
mrem/yr	millirem per year
N	north
NNE	north by northeast
NNW	north by northwest
No.	number
S	south
UC Davis	University of California, Davis
W	west

Table 4-3. LEHR Radiological Dose Reporting Table for Calendar Year 2002

Pathway	Dose to Maximally Exposed Individual [1]		% of DOE 100 mrem/yr Limit	Estimated Population Dose		Population within 80 km[2]	Estimated Background Radiation Population Dose
	(mrem)	(mSv)		(person-rem)	(person-Sv)		(person-rem)
Air	3.8E-04	3.8E-06	3.8E-06	4.44E-05	4.44E-05	111,228[3]	N/A
Water[4]	-	-	-	-	-	-	N/A
Other Pathways[5]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
All Pathways	3.8E-04	3.8E-06	3.8E-06	4.44E-05	4.44E-05	111,228[3]	Not Available

Notes

[1] The effective dose equivalent to the maximally exposed individual is taken as the maximum modeled dose within a 45^o sector in the direction and at the distance indicated in the "location" column. The dose 65 m north of the Western Dog Pens Area, for example, would be the maximum modeled dose at 213 feet (65 meters) N, 213 feet NNE and 213 feet NNW. The maximum total dose is the sum of effective dose equivalents modeled for each maximally exposed individual receptor from potential radionuclide fugitive dust emission non-point sources.

[2] The total population used in calculating the population dose included receptors within a distance of 10 km (6.2 miles) from the Site, rather than 80 km (49 miles) specified in DOE guidance. This modification was necessary to avoid including the large number of receptors in the Sacramento area whose exposure to radionuclides resulting from the Site would be negligible, but whose population numbers would have a large effect on the collective population dose results. This approach is appropriate for calculating the collective population dose for the primarily rural LEHR facility surroundings.

[3] Pathway-specific population is not significantly different from total population.

[4] The water pathway was not measured. Contaminated ground water on the site is not used for drinking. Drinking water in off-site wells has not been impacted by site contamination.

[5] There are no other exposure pathways contributing to a radiological dose at LEHR.

Abbreviations

km	kilometer
LEHR	Laboratory for Energy-Related Health Research
mrem/yr	millirem per year
N/A	not applicable
NNE	north by northeast
NNW	north by northwest
rem	Roentgen equivalent man
mSv	milliSievert

Table 4-4. 2002 Radiological Soil Sampling Results Above Background

Constituents of Concern	Units	Number of Samples Analyzed	Number of Samples > Background[1]	Number of Samples > RBAS[2]	Range of Detections	Maximum Concentration Sample ID	Depth (ft bgs)	Background > 4 ft bgs	RBAS[2]
Domestic Septic System 3									
Bismuth-212	pCi/g	1	1	N/A	0.298	SSD3C036	5.5	0.434	NE
Bismuth-214	pCi/g	1	1	N/A	0.4	SSD3C036	5.5	0.54	NE
Cesium-137	pCi/g	27	1	0	0.0049 – 0.0139	SSD3C036	5.5	0.00695	0.1
Lead-214	pCi/g	1	1	N/A	0.446	SSD3C036	5.5	0.581	NE
Strontium-90	pCi/g	27	19	0	0.0983 – 1.6	SSD3C056	13	0.056	10
Thorium-234	pCi/g	1	1	0	0.524	SSD3C036	5.5	0.78	3.2
DOE Box Area									
Americium-241	pCi/g	10	1	0	0.00471- 0.033	SSDBC019	5.4	0.014	0.092
Carbon-14	pCi/g	10	1	0	0.175	SSDBC033	5.5	0.13	4,200
Lead-214	pCi/g	10	1	N/A	0.345- 0.62	SSDBC020	10	0.581	NE
Plutonium-241	pCi/g	10	2	0	0.426- 1.07	SSDBC019	5.4	0.5	3.2
Strontium-90	pCi/g	10	1	0	0.025- 0.0721	SSDBC004	10	0.056	10
Thorium-232	pCi/g	10	1	10	0.474- 0.82	SSDBC019	5.4	0.8	0.022
Thorium-234	pCi/g	10	2	0	0.436- 1.13	SSDBC031	10	0.78	3.2
Uranium-235	pCi/g	10	4	0	0.0219- 0.074	SSDBC035	5.5	0.038	0.15

Notes

[1]The background concentration for greater than four feet.

[2]Lowest risk-based action standard.

Table 4-4. 2002 Radiological Soil Sampling Results Above Background (continued)

Abbreviations

ft bgs	feet below ground surface
ID	identification (number)
N/A	not applicable
NE	not established
pCi/g	picoCuries per gram
RBAS	risk-based action standard

Table 4-5. LEHR Thermoluminescent Dosimeter Monitoring Results for Calendar Year 2002

Location[1]	Total Annual Dose (mrem)	Dose Associated with DOE Activities[2] (mrem)
TLD-01	78	-1
TLD-02	78	-1
TLD-03	67	-12
TLD-07	74	-5
TLD-08	76	-3
TLD-09	73	-6
TLD-11	73	-6
TLD-12	72	-7
TLD-13	77	-2
TLD-14	82	3
TLD-15	72	-7
TLD-16	68	-11
TLD-17	70	-9
TLD-18	72	-7
TLD-19	78	-1
TLD-20	80	1
TLD-21	73	-6
TLD-23	72	-7
TLD-24	76	-3
TLD-25	80	1
TLD-26	73	-6
TLD-35 Background[3]	**79**	**0**
TLD-36	62	-17
TLD-WDP-N	77	-2
TLD-WDP-E	57	-22
TLD-WDP-S	72	-7
TLD-WDP-W	76	-3
TLD-A	84	5
TLD-B	71	-8
TLD-37[4]	14	-65

Notes

[1] Locations shown on Figure 4-2.

[2] Measured dose, less background.

[3] Background is measured at TLD-35.

[4] TLD installed in November 2002.

Abbreviations

DOE	United States Department of Energy
TLD	thermoluminescent dosimeter
mrem	millirem

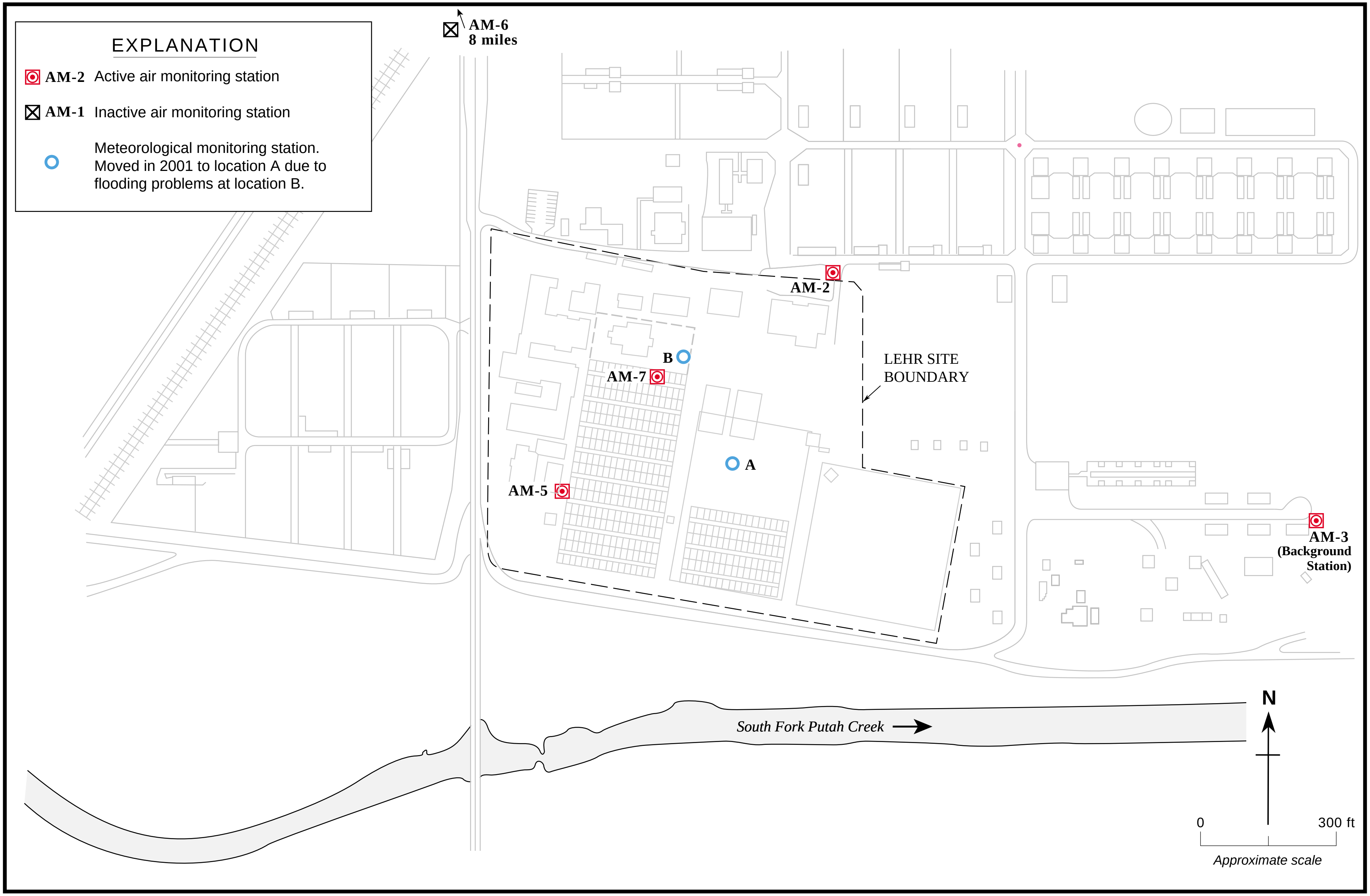

Figure 4-1. Air Monitoring Station Locations

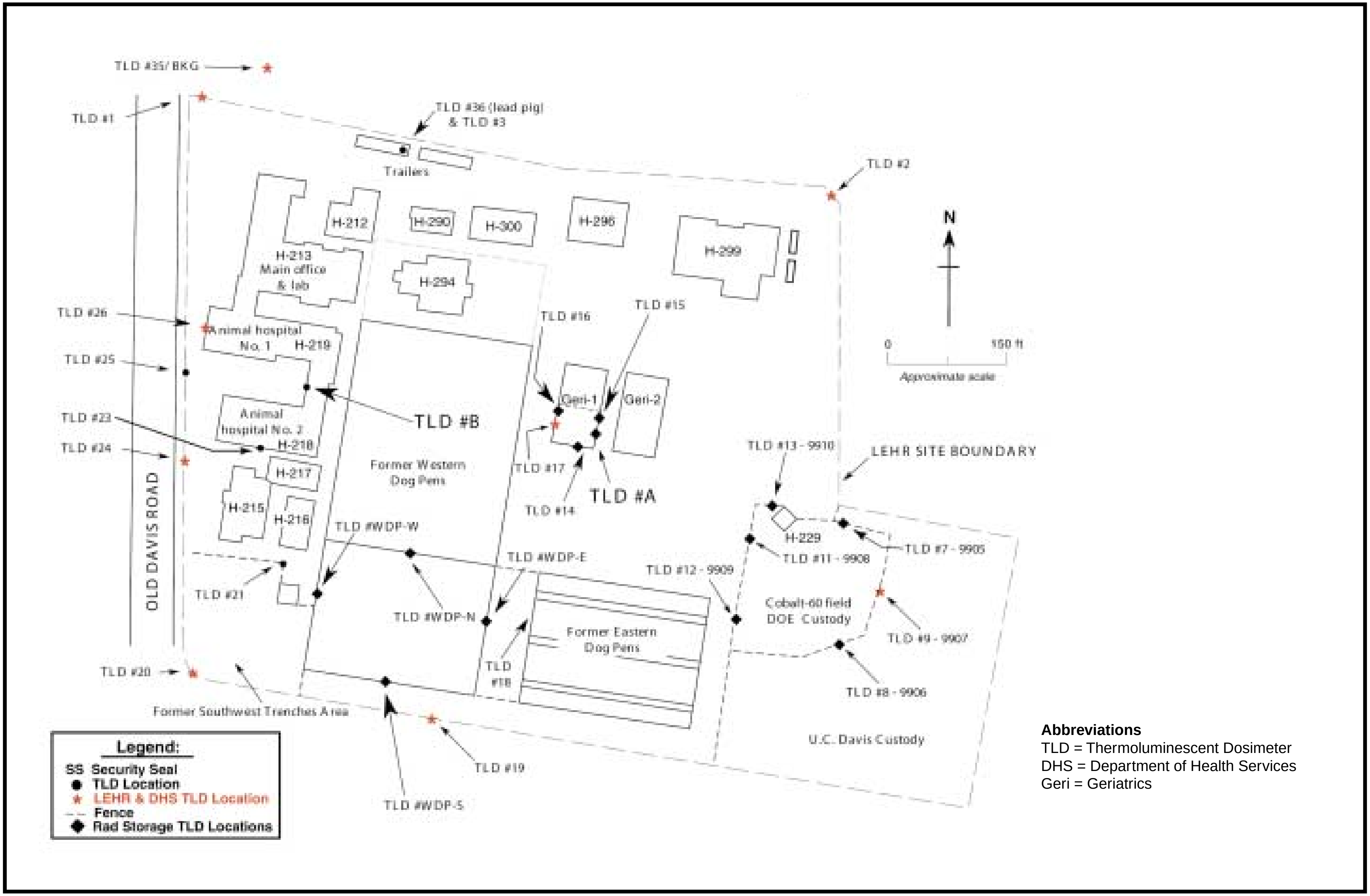

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Figure 4-2. Thermoluminescent Dosimeter Location Map

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5. ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM INFORMATION

This section summarizes significant results and trends in 2002 non-radiological LEHR site air, soil and water monitoring.

5.1 Non-Radiological Air Monitoring

Air monitoring for non-radiological constituents was performed to detect potential releases of non-radiological constituents into ambient air resulting from the 2002 Domestic Septic System 3 and 6 removal action. Based on the contaminants of concern detected in soil at the Domestic Septic Systems 3 and 6 areas prior to the 2002 removal action, air sampling was conducted once during removal action activities to monitor for potential releases of barium, cadmium, chlordane, chromium, copper, heptachlor epoxide, lead, mercury, silver, and particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) into ambient air.

Table 5-1 presents the average and maximum concentrations, the Occupational Safety and Health Administration's permissible exposure limits, and preliminary remediation goals for the air contaminants of concern that were monitored.

Since there was only one sampling event, there were not adequate data to perform statistical tests. The average air concentrations from the three air monitoring stations on site were calculated and compared to the concentrations detected at background station AM-3 (Figure 4-1). Chlordane, silver and heptachlor epoxide were not reported at concentrations greater than their detection limits and therefore were not included in this evaluation. All of the average air concentrations, with the exception of chromium, were above background (Table 5-1). All of the maximum detected air concentrations were compared to the appropriate regulatory limits. All air concentrations of metals were below their respective preliminary remediation goals and permissible exposure limits, with the exception of chromium. Chromium exceeded its preliminary remediation goal for ambient air, but was well below the Occupational Safety and Health Administration's permissible exposure limit.

The EPA specifies a size-specific air quality standard for PM_{10} ambient air particulate (Federal Register, 1987) and has established a screening level for sensitive groups of 150 micrograms per cubic meter ($\mu g/m^3$) for a 24-hour average exposure period. Above this level, the EPA recommends that sensitive groups, including children, the elderly, and people with heart or lung disease, reduce their exposure.

Air monitoring for PM_{10} was conducted at the site air monitoring stations in 2002 and indicated that PM_{10} concentrations did not exceed the 150 micrograms per cubic meter standard for a

24-hour period. The highest recorded PM_{10} concentration for the Domestic Septic Systems 3 and 6 removal actions was 20.6 $\mu g/m^3$ for a 24-hour period.

5.2 Non-Radiological Soil Monitoring

5.2.1 Domestic Septic System 1

Preliminary designated-level analysis was conducted on soil data collected at Domestic Septic Tank 1 during the Limited Field Investigation in 1996 and the 2001 Domestic Septic System Investigation (WA, 2003a). The preliminary designated-level analysis identified that hexavalent chromium was of potential concern. In October 2002, one designated-level boring was drilled at sample location SSD1C001 where the maximum hexavalent chromium concentration was reported in the soil surrounding Domestic Septic Tank 1. Sample SSD1C001 was collected 8.7 feet below ground surface and designated-level samples were collected for hexavalent chromium analysis at five-foot intervals starting at 13.7 feet and terminating at 38.7 feet below ground surface. Hexavalent chromium concentrations were detected above the 0.054 milligrams per kilogram (mg/kg) background concentration in all but one (SSDIDL06) of the samples from all of the borings, with no obvious concentration trend with depth. The maximum hexavalent chromium concentration, 0.165 mg/kg, was detected in sample SSD1DL05, collected 23.7 feet below ground surface. All of the hexavalent chromium concentrations were below the lowest risk-based action standard of 3.8 mg/kg.

5.2.2 Domestic Septic System 3

Following the Domestic Septic System 3 removal action, a total of 42 confirmation samples (including five field duplicates) were collected from the Domestic Septic System 3 excavation (WA, 2003b). Both random-based and discretionary hot spot confirmation samples were collected to ensure appropriate evaluation of data against risk-based action standards using a statistically based sampling design. Thirty sample locations (including three field duplicates) were random-based and 12 locations (including two field duplicates) were discretionary.

The random-based grid samples were analyzed for cadmium, copper, lead, mercury, chromium, silver, formaldehyde, alpha and gamma chlordane, heptachlor epoxide, hexavalent chromium, and nitrate. Three tank contents samples (including one field duplicate) and a concrete sample were collected from Domestic Septic Tank 3. At the request of the Remedial Project Managers, an additional sample was collected beneath the effluent line leading from Domestic Septic Tank 3 to the Domestic Septic System 3 distribution box. This sample, SSD3C036, was collected beneath the first pipe joint encountered north of the Domestic Septic System 3 distribution box. All of these samples were analyzed for a full suite of constituents including semi-volatile organic compounds, volatile organic compounds, pesticides, polychlorinated biphenyls, metals, nitrate, hexavalent chromium, and the waste extraction test and toxicity characteristic leaching procedure analyses for mercury.

All of the constituents detected above background in soil confirmation samples are presented in Table 5-3. Mercury was the only constituent detected above its background and risk-based action standard values. The maximum reported mercury concentration, 4.4 mg/kg, was detected in sample SSD3C066, collected 5.2 feet below ground surface on the leach trench's south sidewall. The seven highest mercury concentrations (2.4 to 4.4 mg/kg) were detected in soil samples collected five to six feet below ground surface. All of the mercury concentrations were below the 23 mg/kg preliminary remediation goal for mercuric chloride in residential soil.

In the tank contents samples, mercury, molybdenum, hexavalent chromium, and silver were the only non-radiological constituents detected above the lowest site soil background values. Mercury was the only analyte detected above background and the lowest risk-based action standard at a maximum concentration of 3.2 mg/kg, but below the preliminary remediation goal of 23 mg/kg. In the concrete sample collected from the bottom of Domestic Septic Tank 3, molybdenum and thallium were the only constituents detected above the lowest site soil background. No constituents in these samples were detected above the site's lowest risk-based action standard values (WA, 2003b).

Domestic Septic System Investigation data collected prior to the Domestic Septic System 3 removal action was analyzed to identify constituents that could potentially impact ground water (designated-level analysis)(WA, 2003a). Formaldehyde, hexavalent chromium, carbazole, arsenic, cadmium, chromium, lead, mercury, molybdenum, nitrate, selenium and silver were identified as constituents that require additional evaluation. One designated-level boring was drilled at the first point of perforation on the eastern Domestic Septic System 3 leach line. Designated level samples were collected at one-foot vertical intervals between 13 and 17 feet below ground surface and analyzed for mercury. Designated level samples were collected at five-foot vertical intervals between 15 and 40 feet below ground surface and analyzed for hexavalent chromium, nitrate, semi-volatile organic compounds and metals. Molybdenum, mercury and hexavalent chromium were the only constituents detected above background in the designated level samples. No constituents were detected above their respective risk-based action standard.

5.2.3 Domestic Septic System 4

Preliminary designated level analysis was conducted on soil data collected from the Domestic Septic System 4 area during the Data Gaps Investigation in 1997 and Domestic Septic System Investigation in 2001 to identify Domestic Septic System 4 contaminants of concern that could potentially impact ground water (WA, 2003a). Based on this analysis, hexavalent chromium, chromium, lead, mercury, and selenium are of potential concern. In October of 2002, one Domestic Septic System 4 designated level boring was drilled at the first point of perforation on the western leach line at sample location SSD4C004. A sample from this location contained the maximum detected hexavalent chromium concentration at Domestic Septic System 4, 0.925 mg/kg. A sample composited from this location and beneath the first point of perforation on the southern leach line contained the maximum mercury, lead and selenium concentrations. Sample SSD4C004 was collected 7.8 feet below ground surface; therefore, designated level samples were collected for hexavalent chromium, total chromium, lead, mercury, and selenium analyses at five-foot intervals starting 12.8 feet below ground surface and terminating 37.7 feet below ground surface.

Hexavalent chromium was detected above the background concentration of 0.054 mg/kg in all except one of the samples from all of the borings, with no obvious concentration trend with depth. All of the Domestic Septic System 4 designated level sampling mercury results were below the 0.248 mg/kg site background. Chromium was detected above the site background for greater than four feet below ground surface, 125 mg/kg, in one sample. Sample SSD4DL02, collected 12.8 feet below ground surface, contained chromium at 153 mg/kg. Lead and selenium were detected at concentrations that were slightly above their respective backgrounds, 9.5 and 1.2 mg/kg, respectively. Sample SSD4DL07, collected 37.8 feet below ground surface, contained lead at 9.6 mg/kg. This was the only sample with a concentration that was above background and the risk-based action standard. Sample SSD4DL03, collected 17.8 feet below ground surface, contained selenium at 1.3 mg/kg. None of the designated level contaminants of concern showed a concentration distribution trend with depth (WA, 2003a). Domestic Septic System 4 soil results, designated level model and deionized waste extraction test analyses suggest that only hexavalent chromium may have a local ground water impact above background within the next thousand years.

5.2.4 Domestic Septic Tank 5

Preliminary designated level analysis identified hexavalent chromium as a contaminant of potential concern. (WA, 2003a) In October 2002, designated level sampling was conducted at sample location SSD5C001, the sole sampling location in the Domestic Septic System 5 area. Sample SSD5C001 was collected 7 feet below ground surface; therefore, designated level samples were collected at five-foot intervals starting at 12 feet and terminating 37 feet below ground surface.

Hexavalent chromium concentrations were detected above the background concentration of 0.054 mg/kg in all of the samples from the boring, with no obvious concentration trend with depth. The maximum hexavalent chromium concentration, 0.175 mg/kg, was detected 12 feet below ground surface. All concentrations were below the 3.8 mg/kg risk-based action standard.

5.2.5 Domestic Septic System 6

Following the Domestic Septic System 6 removal action, a total of 33 confirmation samples (including three field duplicates), SSD6C017 through SSD6C049, were collected between 3.7 and 7 feet below ground surface (WA, 2003b). The Domestic Septic System 6 confirmation sampling consisted of 26 soil samples (including three field duplicates) that were collected at grid locations. These samples were analyzed for barium, copper, mercury and hexavalent chromium. At the request of the Remedial Project Managers, seven discretionary samples were also collected from the Domestic Septic System 6 excavation. Three of the discretionary samples, SSD6C044, SSD6C047 and SSD6C048, were analyzed for semi-volatile organic compounds, volatile organic compounds and mercury; three samples, SSD6C043, SSD6C045, and SSD6C046, were analyzed for semi-volatile organic compounds and volatile organic compounds only; and one sample, SSD6C049, was analyzed for mercury only.

Mercury and hexavalent chromium were the only constituents detected above background in the confirmation samples (WA, 2003b). Mercury was the only constituent that was detected above background and the lowest risk-based action standard. The maximum reported mercury concentration, 8 mg/kg, was detected in soil sample SSD6C038, collected 7 feet below ground surface beneath the former location of the Domestic Septic System 6 northeastern leach line. The second highest mercury concentration, 7 mg/kg, was detected in soil sample SSD6C025. This sample was collected 4.4 feet below ground surface, approximately 7 feet west of sample SSD6C038. All mercury concentrations were below the 23 mg/kg residential preliminary remediation goal for mercuric chloride.

Data obtained from during a 2001 Domestic Septic System Investigation and a 1997 Data Gaps Investigation was analyzed to determined if it exceeded the designated levels set by the Regional Water Quality Control Board for watershed protection. The preliminary analysis identified hexavalent chromium, copper and mercury as requiring additional evaluation (WA, 2003a). Borings were drilled at the first points of perforation on the southeastern and northeastern Domestic Septic System 6 leach lines and designated level samples were collected at each boring, at one-foot vertical intervals from 6 to 10 feet below ground surface and at five-foot vertical intervals from 10 to 40 feet below ground surface. These samples were analyzed for mercury. Samples were also collected at five-foot vertical intervals from 6 to 41 feet below ground surface and analyzed for nitrate, total nitrogen, ammonia, copper, and hexavalent chromium.

Hexavalent chromium was detected above background in 15 of 16 designated level soil samples. No obvious concentration trend with depth was observed. Mercury was detected above the 0.248 mg/kg background concentration (for depths greater than 4 feet below ground surface) in six of the 21 samples (not including field duplicates). Five of six samples that had mercury concentrations above the background had high matrix spike recovery. Therefore, a boring was drilled at the same location to re-collect the samples. An additional designated level boring was also drilled at confirmation sample location SSD6C038 where the maximum mercury concentration, 8 mg/kg, was detected. All of the mercury concentrations in the samples collected from these two borings were below background except for 0.72 mg/kg in a sample collected from the boring at sample location SSD6C038 at 30 feet below ground surface.

5.2.6 DOE Disposal Box

Sampling to fill in existing data gaps was conducted at the DOE Disposal Box Area in 2002. Thirty-three samples (including three field duplicates) were collected from the DOE Disposal Box area during the closure sampling (WA, 2003a). Nine soil samples were analyzed for metals, hexavalent chromium, nitrate, volatile organic compounds, semi-volatile organic compounds, pesticides and polychlorinated biphenyls; and 21 were analyzed for cadmium, chromium, mercury, hexavalent chromium and nitrate only.

All of the constituents detected above background at the DOE Disposal Box area are presented in Table 5-3. Mercury and manganese were the only two analytes detected above their respective risk-based action standard and background values. Manganese was detected above these values in only one sample, SSDBC018, collected at 5.4 feet below ground surface. Eleven mercury results ranging from 0.25 to 3.9 mg/kg exceeded both background and the lowest risk-based action standard. The maximum reported mercury concentration, 3.9 mg/kg, was detected in sample SSDBC006, which was collected 4.4 feet below ground surface from the eastern sidewall. All manganese and mercury concentrations were below their respective residential preliminary remediation goal values of 1,800 mg/kg and 23 mg/kg, respectively.

The preliminary DOE Disposal Box area designated level analysis identified that hexavalent chromium, mercury and molybdenum required additional evaluation (WA, 2002c) for potential ground water impact. In October 2002, designated level samples were collected from the DOE Disposal Box area. Samples were collected from designated level boring, DB-DL1, at the location of sample SSDBC009/010 and analyzed for mercury, molybdenum and hexavalent chromium. Sample SSDBC009/010 had the second highest mercury concentration in the DOE Disposal Box area, 2.6 mg/kg, and the third highest hexavalent chromium concentration, 0.446 mg/kg. No molybdenum data were collected from this location; however, the second highest molybdenum concentration, 0.53 mg/kg, was detected in a sample collected approximately five feet north of sample location SSDBC009/010. The mercury, molybdenum and hexavalent chromium data show no concentration distribution trends that indicate a release of contamination. Therefore, sampling for these metals from one boring location was justified. Soil samples were collected from each designated level boring at five-foot intervals for designated level contaminants of concern, with the first sample collected approximately five feet below the original sample depth of 5.5 feet below ground surface to a depth of 35 feet.

All designated level boring mercury results were below the background level and all molybdenum results were below the detection limit. All designated level boring samples, except the deepest sample collected 35-feet below ground surface, had above-background hexavalent chromium concentrations. The maximum hexavalent chromium concentration was 0.244 mg/kg, which was from a sample collected 25 feet below ground surface (background is 0.054 mg/kg). All hexavalent chromium concentrations were below their respective risk-based action standard.

5.3 Non-Radiological Surface and Storm Water Monitoring

In 2002, surface water sampling was conducted and reported by UC Davis. Trends and conclusions drawn from the surface and storm water monitoring results are discussed briefly below. A detailed discussion of results and tables summarizing the analytical data can be found in the Draft 2002 Comprehensive Annual Water Monitoring Report (Brown and Caldwell, 2003).

5.3.1 Surface Water Monitoring

In 2002, UC Davis collected six surface water samples from three locations: PCU, STPO, and PCD (Figure 3-1). Samples were collected during only one rainfall event on November 12, 2002: Observations of sampling points were made during periods of rain other than November 12, 2002, however sufficient water was not available to collect surface water samples. The samples that were collected were analyzed for chronic aquatic toxicity, metals, nitrate, pesticides, polychlorinated biphenyls, total dissolved solids, and volatile organic compounds. Only nitrate and total dissolved solids were detected above the contract-required detection limits. Nitrate was detected in concentrations ranging from 0.596 milligrams per liter (mg/l) at PCU to 7.84 mg/l at STPO. Total dissolved solids were detected in concentrations ranging from 214 mg/l at PCU to 558 mg/l at STPO.

5.3.2 Storm Water Monitoring

All storm water sampling locations were observed during numerous storms throughout the rainy season in 2002; however, only one UCD monitoring location, LF-01, and one DOE monitoring location , LS-1, produced a discharge sufficient for sampling. LS-1 and LF-01 were sampled on November 8 and 9, 2002, respectively.

The sample collected from LF-01 was analyzed for acute aquatic toxicity, metals, nitrate, oil and grease, pesticides, polychlorinated biphenyls, radionuclides, total dissolved solids, total organic carbon, total suspended solids and volatile organic compounds. The following constituents were detected above the contract-required detection limits: acetone at 5.8 µg/l; arsenic at 6.94µg/l; barium at 194 µg/l; boron at 62µg/l; chromium at 64.9 µg/l; cobalt at 20.8 µg/l; copper at 37.8 µg/l; iron at 21,500 µg/l; lead at 31.1 µg/l; manganese at 637 µg/l; mercury at 0.549 µg/l; nickel at 129 µg/l; vanadium at 53.9 µg/l; zinc at 249 µg/l; dieldrin at 0.021µg/l; p,p-dichlorodiphenyl trichloroethane at 0.021 µg/l; nitrate at 0.716 mg/l, total dissolved solids at 91 mg/l and total organic carbon at 10.3 mg/l.

The sample collected from LS-1 was analyzed for metals, nitrate, oil and grease, pesticides, polychlorinated biphenyls, radionuclides, total dissolved solids, total organic carbon, total suspended solids and volatile organic compounds. Analytical results were similar to previous years. Significant results include:

- Chloroform was not reported above the CRDL in any storm water samples collected from the Site in 2002, nor in the previous five years.
- Nitrate was detected below 0.52 milligrams per liter (mg/L), TDS concentration was 70 mg/L, and total chromium was detected at 2.37 µg/L and hexavalent chromium was not detected. These results are consistent with historical trends.
- Arsenic, barium, cadmium, copper, lead, mercury and nickel were detected in storm water samples below their respective primary maximum contaminant levels (MCLs). Antimony was detected at concentrations up to 42.6 mg/L in LS-1, exceeding the MCL of 6 mg/L. The metals concentrations in storm water are consistent with previous years.

5.3.3 National Pollutant Discharge Elimination System Data

The Site discharges its sanitary waste to the UC Davis Waste Water Treatment Plant according to National Pollutant Discharge Elimination System permit requirements. Current DOE/NNSA activities do not contribute to hazardous discharges.

Table 5-1. Domestic Septic Systems 3 and 6 Removal Actions Non-Radiological Air Monitoring Data Summary

Contaminant of Concern	Units	Average Concentration	Maximum Concentration	Background Concentration[1]	PRG	OSHA PEL	Average Concentration > Background?	Maximum Concentration > Regulatory Limit?
Barium	μg/m^3	0.0034	0.004	0.0016	0.52	500	Yes	No/No[2]
Cadmium	μg/m^3	0.0002	0.0002	0.0001	0.0011	5	Yes	No/No[2]
Chromium	μg/m^3	0.0015	0.0017	0.0016	0.000023	500	No	Yes/No[2]
Copper	μg/m^3	0.0203	0.0331	0.0061	N/A	1,000	Yes	No
Lead	μg/m^3	0.0014	0.0019	0.0007	N/A	0.05	Yes	No
Mercury	μg/m^3	5.73E-05	6.76E-05	2.47E-05	0.31[3]	10[4]	Yes	No/No[2]

Notes

[1] The background concentration is the air concentration detected at the background air monitoring station, AM-3, during the Domestic Septic Systems 3 and 6 removal actions.

[2] The left side states whether the maximum concentration is greater than the preliminary remediation goal. The right side states whether the maximum concentration is greater than the permissible exposure limit.

[3] Preliminary remediation goal for elemental mercury

[4] Mercury (aryl and inorganic compounds)

Abbreviations

N/A	not applicable
OSHA	Occupational and Safety Health Act
PEL	permissible exposure limit
PRG	preliminary remediation goal for ambient air
μg/m^3	microgram per cubic meter

Table 5-2. 2002 Non-Radiological Soil Sample Results Above Background

Constituents of Concern	Units	No. of Samples Analyzed	No. of Samples > Background [1]	No. of Samples > RBAS [2]	Range of Detections	Maximum Concentration Sample ID	Depth (ft bgs)	Background Concentration (> 4ft bgs) [3]	RBAS [2]
Domestic Septic System 3									
General Chemistry									
Formaldehyde	mg/kg	27	27	1	0.21 – 2.2	SSD3C055	12	N/A	1.7
Hexavalent Chromium	mg/kg	27	22	0	0.0513 – 0.384	SSD3C046	5.9	0.054	3.8
Nitrate	mg/kg	27	7	N/A	1.15 -106	SSD3C049	12.5	36	NE
Metals									
Chromium	mg/kg	27	17	0	76.9 – 174	SSD3C047	5.9	125	720
Mercury	mg/kg	27	27	15	0.24 – 4.4	SSD3C066	5.2	0.248	1.13[4]
Selenium	mg/kg	1	1	0	1.1	SSD3C036	5.5	1.2	58
Silver	mg/kg	27	3	0	0.29 – 2.4	SSD3C053	10.5	0.55	3.8
Pesticides									
alpha-Chlordane	µg/kg	27	19	0	2 – 161	SSD3C047DL	5.9	N/A	800
gamma-Chlordane	µg/kg	27	19	0	2.2 – 294	SSD3C047DL	5.9	N/A	810
Heptachlor epoxide	µg/kg	27	1	0	4	SSD3C061	5.2	N/A	68.9 [4]
Domestic Septic System 6									
General Chemistry									

Table 5-2. 2002 Non-Radiological Soil Sample Results Above Background (continued)

Constituents of Concern	Units	No. of Samples Analyzed	No. of Samples > Background [1]	No. of Samples > RBAS [2]	Range of Detections	Maximum Concentration Sample ID	Depth (ft bgs)	Background Concentration (> 4ft bgs) [3]	RBAS [2]
Hexavalent Chromium	mg/kg	23	6	0	0.0435 – 0.362	SSD6C023	4.4	0.054	3.8
Metals									
Mercury	mg/kg	23	21	12	0.01 – 8	SSD6C038	7	0.248	0.77[5]
DOE Disposal Box									
General Chemistry									
Hexavalent Chromium	mg/kg	7	7	0	0.164- 0.552	SSDBC034	5.5	0.054	3.8
Nitrate	mg/kg	30	1	N/A	2.09- 58.7	SSDBC014	10	36	NE
Metals									
Chromium	mg/kg	30	5	0	91.7- 140	SSDBC028	10	125	720
Manganese	mg/kg	10	1	1	491- 800	SSDBC018	5.4	750	36
Mercury	mg/kg	30	11	12	0.097- 3.9	SSDBC006	4.4	0.248	0.22
Molybdeum	mg/kg	10	10	N/A	0.28- 0.62	SSDBC004	10	0.26	NE
Selenium	mg/kg	10	2	0	0.68- 1.5	SSDBC019	5.4	1.2	58

Notes

1 Background greater than 4 ft bgs.
2 Lowest risk-based action standard.
3 Background Concentration = 80% lower confidence limit on 95th percentile of background data > 4 ft bgs. Background value was determined from samples collected at depths greater than 4 feet below ground surface when constituent concentration was known to vary with depth.
4 Scenario 2 RBAS is specific to potential source soil in the Domestic Septic System 3 area.
5 Scenario 2 RBAS is specific to potential source soil in Domestic Septic System 6 area.

Table 5-2. 2002 Non-Radiological Soil Sample Results Above Background (continued)

Abbreviations

bgs	below ground surface
ft	feet
mg/kg	milligrams per kilogram
N/A	not applicable
No.	number
RBAS	Risk-Based Action Standard; 10-6 risk for carcinogenic effects and a hazard quotient of 1.0 for non-carcinogenic effects (WA, 1997).
µg/kg	micrograms per kilogram
ID	identification

6. WATER MONITORING AND PUBLIC DRINKING WATER PROTECTION PROGRAM

Ground water monitoring has been conducted at the Site since November 1990. Quarterly monitoring began as a component of the Phase II Site Characterization (Dames & Moore 1993). In 1993, a site water monitoring plan was developed to meet the requirements of DOE's General Environmental Protection Program under DOE Order 5400.1. In 1997, a Memorandum of Agreement between DOE and UC Davis transferred responsibility for ground water sampling from DOE to UC Davis. The ground water monitoring program discussed in this section is the responsibility of UC Davis.

In 1998, UC Davis began operating and monitoring a ground water interim remedial action system to reduce off-site migration of volatile organic compounds, primarily chloroform. In 1999, quarterly monitoring began as part of the site Remedial Investigation focusing on six constituents of concern: volatile organic compounds (primarily chloroform), hexavalent chromium, nitrate, total dissolved solids, tritium and carbon-14. The monitoring data were included in a Draft Remedial Investigation Report submitted to the EPA (WA, 2003a).

During 2001, two additional water-monitoring programs were initiated for a land treatment pilot study and a density-driven convection system pilot test. The land treatment pilot study was installed to address exceedence of waste discharge requirements for the ground water interim remedial action. Monitoring for this program is detailed in the Land Treatment Pilot Study Work Plan (Montgomery Watson, 2000) and follows the requirements issued in the EPA’s Statement of Work for Removal Actions and Mitigation Repair (EPA, 2000). The density-driven convection pilot system located in the vicinity of well UCD1-12 (Figure 3-1) was installed to assess the effectiveness of this technology in removing the source of volatile organic compounds, primarily chloroform, in the shallow ground water at the Site.

In 2002, all ground water monitoring at the Site was performed and reported by UC Davis. The results of the water monitoring are summarized briefly here, and are discussed in detail in the Draft 2002 Comprehensive Annual Water Monitoring Report (Brown and Caldwell, 2003). Figure 3-1 shows the location of LEHR ground water monitoring wells.

6.1 Uses of Ground Water in the LEHR Vicinity

As discussed in Sections 1.4.2 and 1.4.3, local ground water is utilized for both drinking and agricultural purposes. The major ground water sources for both public and private water supplies in the Sacramento Valley are unconsolidated deposits of Pliocene and Pleistocene age, and older alluvium (DOE, 1992b). Water from the first HSU is not used for drinking or irrigating purposes due to inadequate yield. A number of domestic and irrigation wells in the site vicinity produce water from HSU-2.

6.2 Potential Sources of Ground Water Pollution

Sources contributing to ground water pollution at the Site include the UC Davis Landfill No. 2 (source of volatile organic compounds) and the UC Davis Waste Burial Holes (Figure 1-2) (source of tritium and carbon-14 contamination). UC Davis landfills and the former animal handling facilities at LEHR may be potential sources of nitrate contamination in the site ground water.

6.3 Ground Water Monitoring

The ground water monitoring program and the 2002 sampling results are summarized below and discussed in detail in the Draft 2002 Comprehensive Annual Water Monitoring Report (Brown and Caldwell, 2003). All sampling and analytical procedures implemented as part of the program were conducted in accordance with the Final Revised Field Sampling Plan (Dames & Moore, 1998a) and the Final Revised Quality Assurance Project Plan (Dames & Moore, 1998b). Isoconcentration maps for HSU-1 and HSU-2 through time are included in Appendix A.

In the 2001 Annual Water Monitoring Report (URS, 2002), UC Davis recommended several changes to the overall water-monitoring program, which were approved by the EPA in July 2002. Three programs were identified for continued monitoring:

- The expanded density-driven convection pilot test system;
- The land treatment pilot study; and
- A combined program for the interim remedial action and water monitoring program.

Since the changes to the monitoring program were not approved until July of 2002, monitoring for 2002 followed both the previous and the modified programs. The 2002 water monitoring program included the following components:

- Expanded Density-Driven Convection Pilot Test Program Monitoring;
- Remedial Investigation Water Monitoring; and;
- Interim Remedial Action Monitoring.

Each of these is briefly described below.

6.3.1 Expanded Density-Driven Convection Pilot Test Program Monitoring;

As part of the ground water monitoring program, five sampling rounds (one baseline and four weekly) of the expanded density-driven convection pilot test system, which began operation on December 5, 2002, were collected in December 2002. Two sampling rounds were collected earlier in 2002 to assess the system operation during the initial phase. The initial results, combined with data from the overall water monitoring program, suggest that the system is operating as intended and has significantly reduced the mass of chloroform reaching HSU-2. The surface of the chloroform is UC Davis Landfill No. 2.

6.3.2 Remedial Investigation Water Monitoring Program

The objective of the ground water monitoring for the Remedial Investigation is to assess if unexpected changes in ground water occurred that warrant changes to the program. Changes to the Ground Water Monitoring Program were implemented in August 2002. From January to July 2002, 24 wells were sampled quarterly and six additional wells were sampled annually in spring (May) when ground water levels are typically higher. Four new wells were added for the density-driven convection system. Of the 34 monitoring wells used for the Remedial Investigation monitoring, 28 wells are sampled semi-annually and six wells are sampled annually. Semi-annual and annual samples are submitted for six analyses: volatile organic compounds, chromium, nitrate, total dissolved solids, carbon-14, and tritium. Besides carbon-14 and tritium, no other radionuclides are monitored. Additional samples are collected from wells UCD1-18, UCD1-11, UCD1-25, and UCD1-27 Z1 through Z3 and UCD1-28 to monitor ground water upgradient and under the land treatment pilot system.

6.3.3 Interim Remedial Action Monitoring Program

UC Davis operates an interim remedial action treatment system to control and reduce ground water contamination at the Site. The system utilizes both injection and irrigation for discharge of treated ground water. Monitoring of the system is conducted by UC Davis to assess the effect of the interim remedial action treatment system on the contaminant plume. Throughout 2002, the interim remedial action treatment system operated 85 percent of the time. Events that contributed to its downtime are detailed in monthly and quarterly reports issued during 2002.

In 2002, the interim remedial action treatment system removed a total of 9.6 pounds of chloroform, an increase of 88 percent from the mass removed in 2001. This increase is largely due to the fact that system operated more in 2002 than in 2001. Effluent discharged via injection met discharge standards during 2002, with a few exceptions detailed in the Draft 2002 Comprehensive Annual Water Monitoring Report (Brown and Caldwell, 2003).

The land treatment pilot study system began full-scale operation in July 2002, delivering water to pastures four to six times per day during July and three to four times per day in August and

September. Monitoring of the system in 2002 showed that effluent discharges achieved all effluent standards except for chloroform, which exceeded the discharge standard of 5.0 μg/L in June and July.

6.3.4 Monitoring Results for Radionuclides

Carbon-14 and tritium have been detected during historical monitoring activities at the Site. In 1999, UC Davis conducted a removal action at the Waste Burial Holes (Figure 1-2) to remove the sources of carbon-14 and tritium. At the end of 2001, HSU-2 wells downgradient of this source area indicated decreased contaminant concentrations. The 2002 monitoring results for radionuclides are summarized below by HSU.

HSU-1: Carbon-14 was detected in three of the nine HSU-1 wells sampled in 2002, consistent with 2001 results which ranged from 12±6.57 pCi/l in UCD1-28 to 951±19.9 pCi/l in UCD1-13. See Appendix A for carbon-14 isoconcentration contours in HSU-1.

Of the seven HSU-1 wells sampled in 2002, tritium was detected only in UCD1-13. The highest tritium activity in UCD1-13 was 11,800±437 pCi/l, which is consistent with typical activity in that well. Figure 6-1 shows the changes in tritium concentration in the UCD1-13 well.

HSU-2: Since site ground water monitoring began, carbon-14 has been consistently detected in UCD2-14 near the Waste Burial Holes at activities averaging 500 pCi/l. During 2002, carbon-14 in UCD2-14 was detected between 61 pCi/l (November 2002) and 367 pCi/l (August 2002). Carbon-14 was also detected in HSU-2 well UCD2-39 at 20.8 ± 6.9 pCi/l, just above the contract-required detection limit.

Tritium was detected in one HSU-2 well, UCD2-14, ranging from 305 ±143 pCi/l in February to 2,706 pCi/l in August. These activities are within historical ranges for these wells.

HSU-4: In 2002, neither carbon-14 nor tritium was detected in HSU-4 wells in concentrations above the contract-required detection limit.

6.3.5 Non-Radionuclides

Ground water monitoring results for 2002 for non-radionuclides are summarized below by HSU.

HSU-1: Fourteen volatile organic compounds were detected in HSU-1 above the contract-required detection limit: chloroform; 1,1,2-trichloroethane; 1,1-dichloroethane; 1,1-dichloroethene; 1,2-dichloropropane; acetone; benzene; chloromethane; ethylbenzene; methylene chloride; tetrachloroethylene; toluene; and trichlorethylene. Chloroform was detected in eight of the nine HSU-1 wells (UCD1-11, UCD1-12, UDC1-13, UDC1-25, UDC1-28, UDC1-49, UDC1-50, and UDC1-51) in concentrations ranging from 0.37 μg/L (UCD1-28 on November 3, 2002) to 3,130 μg/L

(UCD1-50 on August 28, 2002). Chloroform isoconcentration contour maps are provided in Appendix A.

Benzene at 1.6 μg/, ethylebenzene at 31 μg/L, toluene at 0.73 μg/L, and xylenes at 1 μg/L were reported in the sample collected from UCD1-12 on May 28, 2002. Two-hexanone at 0.32 μg/L and methyl isobutyl ketone at 0.27 μg/L were reported only in the sample collected from UCD1-12 on February 21, 2002. Chloromethane at 0.67 μg/L was reported only in the sample collected from UCD1-18 on November 5, 2002. Chloromethane has not been previously detected in UCD1-18, and the reported detection in November was just above the contract-required detection limit.

Concentrations of chromium, nitrate and total dissolved solids in HSU-1 were within the historical range. Isoconcentration contour maps for these contaminants are provided in Appendix A.

HSU-2: Four volatile organic compounds were detected above the contract-required detection limit in HSU-2 ground water samples: chloroform; 1,1-dichloroethane; 1,2-dichloroethane; and 1,2-dichloropropane. Chloroform was detected in thirteen of the eighteen HSU-2 wells (UCD2-14, UCD2-15, UCD2-26, UCD2-29, UCD2-30, UCD2-31, UCD2-14, UCD2-32, UCD2-39, UCD2-40, , UCD2-45, UCD2-46, and , UCD2-48) in concentrations ranging from 0.29 μg/L (UCD2-46 on February 4, 2002) to 104 μg/L (UCD2-29 on June 4, 2002). Chloroform isoconcentration contour maps are provided in Appendix A.

HSU-4: Chloroform was the only volatile organic compound reported above the contract-required detection limit in HSU-4 ground water samples. Chloroform was detected in all four HSU-4 wells (UCD4-41, UCD4-42, UCD4-43, and UCD4-47) in concentrations ranging from 0.54 μg/L (UCD4-41 on May 7, 2002) to 4.6 μg/L (UCD4-43 on February 6, 2002 and UCD4-47 on August 13 and November 4, 2002).

Concentrations of chromium, nitrate and total dissolved solids in HSU-4 were within the historical range. Isoconcentration contours of these parameters are provided in Appendix A.

6.4 Off-Site Supply Well Sampling

Private wells south, north, and east of the Site have been sampled since 1989. Because these wells are not consistently constructed, comparisons cannot be made between these wells and those at the Site. The off-site supply well sampling program has provided general information about the primary site constituents of concern: volatile organic compounds, tritium, hexavalent chromium, nitrate as nitrogen, gross alpha and gross beta. Monitoring of radiological constituents in private wells ceased in 1996 because no radiological contamination that could be attributed to the LEHR site was found in any off-site supply well.

In 2002, UC Davis sampled irrigation and domestic wells east and south of the Site (Figure 6-2).

In 2002, UC Davis sampled irrigation and domestic wells east and south of the Site three times (spring, summer and fall) (Figure 6-2). As in 2001, nitrate as nitrogen was detected in seven of the sixteen wells sampled. Hexavalent chromium was detected in seven of the ten wells sampled. These compounds are present in regional ground water, and no direct link to the Site has been established.

In 2001, the only VOC found above the detection limit in off-site private wells was 1,1-Dichloroethylene. It was detected in concentrations from 0.28 to 0.59 µg/L in the summer samples collected from off-site wells, NDW (15P),OHDW (14L), RDW, and MDW. 1,1-Dichloroethylene was not detected in the same wells in subsequent samples collected during the fall of 2001. All of the summer sample results were below the EPA Maximum Contaminant Level for drinking water for 1,1-Dichloroethylene of 6 µg/L and were substantially lower than samples collected in the summer of 2000. Based on the 1,1-Dichloroethylene concentrations observed in the LEHR site wells (maximum 0.89 µg/L) the concentrations found in the off-site wells do not appear to be attributed to the LEHR site. Analysis of one sample collected at well IHDW (15K3) in the fall of 2002 indicated the presence of 2-butanone, however data validation suggests that the analytical result is likely due to laboratory contamination. .

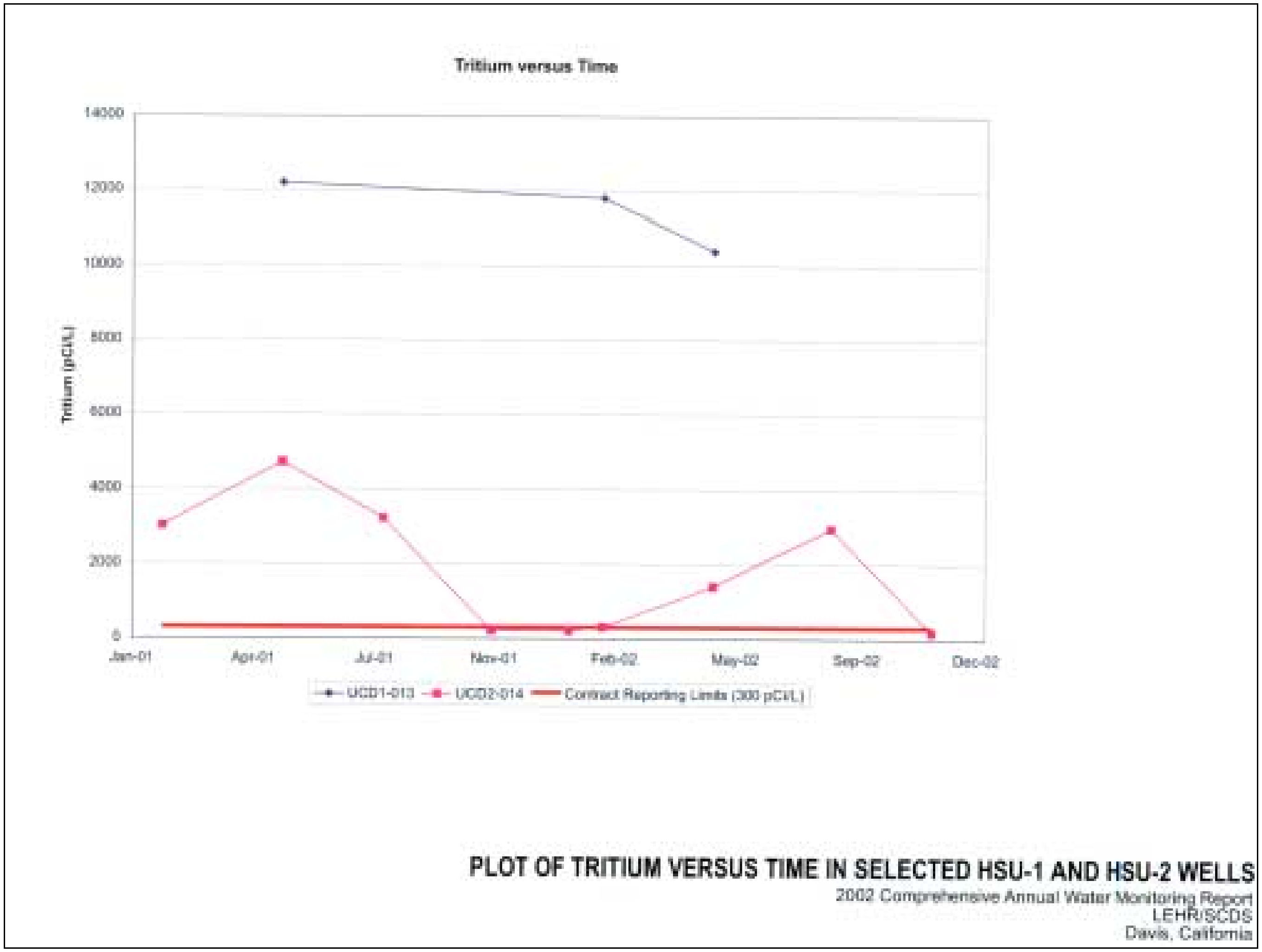

Figure 6-1. Tritium Concentrations in Hydrostratigraphic Unit-2 Over Time *Weiss Associates*

NOTE: PLOT of TRITIUM FROM BROWN AND CALDWELL

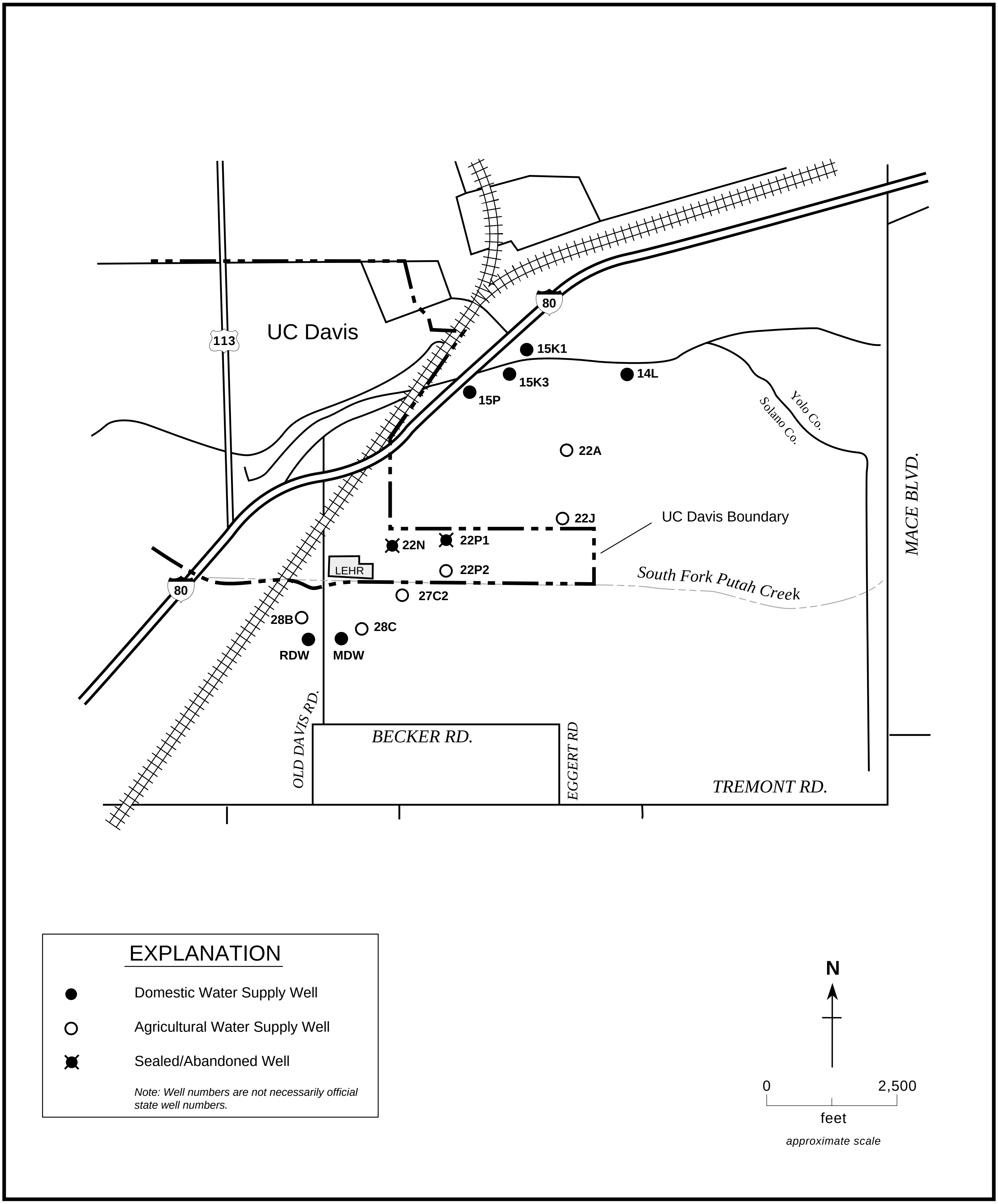

Figure 6-2. Neighbor Well Sampling Program Locations Near the LEHR Site

Weiss Associates

7. QUALITY ASSURANCE

Quality assurance is a key element of the environmental protection program for the Site. A Quality Assurance Project Plan (WA, 2000a) that describes the requirements for all quality-related work on the LEHR project has been prepared and is fully implemented. The Quality Assurance Project Plan and other quality-assuring documents, such as standard quality procedures, standard operating procedures and task-specific work plans, govern all phases of the LEHR program, including site characterization, investigation, risk assessments, decontamination and decommissioning, waste management and site restoration. The purpose of the Quality Assurance Project Plan and the other documents is to identify the specifications and methods employed to establish technical accuracy, precision and validity of measurements and statistics, and to provide a sound basis for management decisions based on environmental information collected for the Site. The Quality Assurance Project Plan for the LEHR project was prepared in accordance with EPA QA/R-5 (EPA, 2001) and National Quality Assurance specifications. It also conforms to DOE Order 414.4a, the Nuclear Safety Management Quality Assurance Requirements in Title 10 of the Code of Federal Regulations, Part 830, and incorporates requirements of DOE Order 5400.1, General Environmental Protection, to ensure that DOE quality and environmental goals are met.

Environmental samples collected by DOE/NNSA that are discussed in this report were collected, analyzed, reviewed and validated according to the Quality Assurance Project Plan and other relevant standard operating procedures and/or task-specific work plans. To assure quality, quality control is integrated into all aspects of environmental sampling. Included in the Quality Assurance Project Plan and related documents are sections identifying quality control for sample collection requirements and specific quality assurance objectives for the measureme nt data. Quality control samples are run with each sample batch at the analytical laboratory to validate the method of analysis and the proficiency of the analyst. Because holding times are important to sample quality, they are carefully controlled. To ensure comparability of analytical data, all samples are analyzed by EPA-approved methods when available. When analytical results are received, they are reviewed according to the appropriate data quality objectives and data review procedures. All of the 2002 site air, soil, and water monitoring data have been presented in other reports. The specific review and validation process for each data set are presented in these reports, and are not discussed in detail here.

7.1 Field Quality Assurance

Quality assurance for field sampling is accomplished by collecting field duplicates, decontamination rinseates, trip blanks and field blanks, as appropriate. For each round of sampling, duplicate samples are collected from a selected sample point at the same location as the original sample to check for consistency in the sampling process. The duplicate sample serves as a check on the precision of the sampling and analytical procedures. Decontamination rinseates are analyzed whenever the potential exists for cross-contamination from sampling equipment. Trip blanks are sent with each shipment of water samples requiring analysis for volatile organic compounds. Field blanks are collected to check for contamination during the water sampling process. Calibration records for each field instrument are maintained in the project files.

7.2 Laboratory Quality Assurance

Contracted laboratories providing analytical services for the LEHR project are evaluated by Weiss Associates or UC Davis to ensure compliance with the quality assurance program requirements. Laboratory quality assurance is analyzed externally by submitting split samples, spiked samples, and blanks to the laboratories analyzing environmental samples. Laboratories must submit their analytical procedure for review if it differs from standard procedures. Each contract laboratory is required to maintain participation, as applicable, in DOE, State of California, and/or EPA-approved inter-laboratory quality assurance programs such as DOE's Environmental Measurement Laboratory Inter-Laboratory Comparison Program or EPA's Water Pollution/Water Supply Program.

7.3 Compliance Audits

Aspects of the LEHR program are audited periodically to ensure compliance with project standards. Several health and safety and quality assurance audits or surveillances with an Integrated Safety Management System component, and a Radiation Protection Program audit were performed in 2002. All findings and observations identified during the audits have been, or will be, resolved.

7.4 Summary of Quality Control Data Validation

The overall LEHR quality assurance objective is to collect and analyze environmental samples from the Site in a manner that ensures technical data are accurate and representative, are able to withstand scientific and legal scrutiny, and are useful for evaluating site conditions and remedial actions. The criteria used to specify quality assurance goals are precision, accuracy, representativeness, completeness and comparability for evaluation of quality control data. These parameters are evaluated through data validation. Table 7-1 summarizes the components used to monitor and evaluate the quality of LEHR environmental data.

Table 7-1. Components of the LEHR Quality Control Program in Support of Data Quality Objectives

Data Quality Objective	Quality Control Component	Evaluation Criteria
Precision	• Field duplicate • Matrix spike • Matrix spike duplicate	Relative percent difference
Accuracy	• Matrix spike • Matrix spike duplicate • Surrogate spikes	Percent recovery
Representativeness	• Trip blanks • Field duplicate • Method blanks	Qualitative degree of confidence
Completeness	• Holding time • Valid data points	Percent valid data
Comparability	• Analytical methods • Field duplicates	Qualitative degree of confidence

8. DEFINITIONS[1]

Term	Definition
absorbed dose	The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).
as low as reasonably achievable (ALARA)	A phrase (acronym) used to describe an approach to radiation protection to control or manage exposures (both individual and collective to the work force and the general public) and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. As used in United States Department of Energy (DOE) Order 5400.5, ALARA is not a dose limit, but rather it is a process that has as its objective the attainment of dose levels as far below the applicable limits of the Order as practicable.
collective dose equivalent and collective effective dose equivalent	The sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within an 80-kilometer (km) radius, for the purposes of DOE Order 5400.5, and they are expressed in units of person-Roentgen equivalent, man (rem), (or person-sievert). When the collective dose equivalent of interest is for a specific organ, the units would be organ-rem (or organ-sievert). For purposes of DOE Order 5400.5, the 80-km distance shall be measured from a point located centrally with respect to major facilities or DOE program activities.
committed dose equivalent	The predicted total dose equivalent to a tissue or organ over a 50-year period after a known intake of a radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem (or sievert).

[1] Definitions are adapted from Department of Energy Order 5400.5, and United States Environmental Protection Agency.

Term	Definition
committed effective dose equivalent	The sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem (or sievert).
confirmation samples	Analysis for metals, nitrate, pesticides/polychlorinated biphenyls, semi-volatile organic compounds, volatile organic compounds and hexavalent chromium.
Curie (Ci)	A unit of radioactivity equal to 3.7×10^{10} disintegrations per second.
derived concentration guide	The concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in an effective dose equivalent of 100 millirem (1 millisievert). Derived concentration guides do not consider decay products when the parent radionuclide is the cause of the exposure (derived concentration guide values are presented in Chapter III of DOE Order 5400.5).
designated level	Cleanup levels for specific constituents of a waste that provide a site specific indication of the water quality impairment potential of the waste. Designated levels are calculated by first determining the bodies of water that may be affected by a waste and the present and probable future beneficial uses of these waters. Next, site-specific “water quality goals” are selected, based on background water quality or accepted criteria and standards, to protect those beneficial uses. Finally, these water quality goals are multiplied by factors that account for environmental attenuation and leachability. The result is a set of Soluble and Total Designated levels that are applicable to a particular waste and disposal site and which, if not exceeded, should protect the beneficial uses of waters of the State. Wastes having constituent concentrations in excess of these Designated levels are assumed to pose a threat to water quality and are, therefore, classified as ‘designated wastes’ and directed to waste management units that isolate these wastes from the environment.

Term	Definition
DOE Orders	DOE directives intended to direct, guide, inform, and instruct DOE employees in the performance of their jobs, and enable them to work effectively within the DOE and with agencies, contractors, and the public.
dose equivalent	The product of absorbed dose in rad (or gray) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert).
effective dose equivalent	The summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the health-effects risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent due to penetrating radiation from sources external to the body. Effective dose equivalent is expressed in units of rem (or sievert).
effluent monitoring	The collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying contaminants, assessing radiation exposures of members of the public, and demonstrating compliance with applicable standards.
environmental surveillance	The collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from DOE sites and their environs, and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing radiation exposures of members of the public, and assessing effects, if any, on the local environment.

Term	Definition
hazard index	The health impact of the non-carcinogenic compounds is quantified through the hazard index, which is the ratio of the expected concentration of a compound to the acceptable concentration of the compound. When more than one toxic compound is emitted, the hazard indices of the compounds are summed to give the total hazard index. A total hazard index of 1.0 or less is considered to be not significant and the resulting impact on public health is deemed acceptable.
maximally exposed individual	The maximally exposed individual is the representative member of the public who receives the highest estimated effective dose equivalent based on the sum of the individual pathway doses.
members of the public	Persons who are not occupationally associated with a DOE facility or operations (i.e., persons whose assigned occupational duties do not require them to enter the DOE site). Also see: public dose.
picoCurie(pCi)	A unit of radioactivity equal to 1 x 10^{-12} curies or 2.2 disintegrations per minute.
preliminary remediation goal	Initial clean-up goals that (1) are protective of human health and the environment and (2) comply with applicable or relevant and appropriate requirements. Preliminary remediation goals are developed early in the remedy selection process based on readily available information and are modified to reflect results of the baseline risk assessment. They also are used during analysis of remedial alternatives in the remedial investigation/feasibility study.
public dose	The dose received by member(s) of the public from exposure to radiation and to radioactive material released by a DOE facility or operation, whether the exposure is within a DOE site boundary or off site. It does not include dose received from occupational exposures, doses received from naturally occurring "background" radiation, doses received as a patient from medical practices, or doses received from consumer products.
quality factor	The principal modifying factor used to regulate the dose equivalent from the absorbed dose. For the purposes of DOE Order 5400.5, quality factors taken from DOE Order 5480.11 are to be used.

Term	Definition
rad	Historical unit of measurement of the radiation energy absorption (dose) in matter. The rad is defined as the amount of radiation required for absorption of 100 ergs (1 erg = 10-7. joule) per gram of irradiated material.
radioactivity	Property or characteristic of radioactive material to spontaneously "disintegrate" with the emission of energy in the form of radiation. The unit of radioactivity is the curie (or becquerel).
reference man	A hypothetical aggregation of human (male and female) physical and physiological characteristics arrived at by international consensus (International Council for Radiation Protection Publication 23). These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological effects from ionizing radiation to a common base. The "reference man" is assumed to inhale 8,400 cubic meters of air in a year and to ingest 730 liters of water in a year.
remedial action	Those actions consistent with permanent remedy taken instead of, or in addition to, removal action in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment.
residual radioactive material	Any radioactive material which is in or on soil, air, equipment, or structures as a consequence of past operations or activities.
RESRAD	Residual Radioactivity model. Argonne National Laboratory computer model for evaluating radioactively contaminated sites. (Argonne National Laboratory)
risk-based action standard	Site-specific soil contaminant-specific concentrations above which an unacceptable risk to human health is predicted to exist. An unacceptable risk to human health is defined as exceeding a one-in-one million excess cancer risk over a 60-year exposure period.
roentgen	A unit of radiation exposure equal to the quantity of ionizing radiation that will produce one electrostatic unit of electricity in one cubic centimeter of dry air at 0°C and standard atmospheric pressure.

Term	Definition
roentgen equivalent man (rem)	The dosage of ionizing radiation that will cause the same biological effect as one roentgen of x-ray or one gamma-ray dosage.

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10. ACKNOWLEDGMENTS

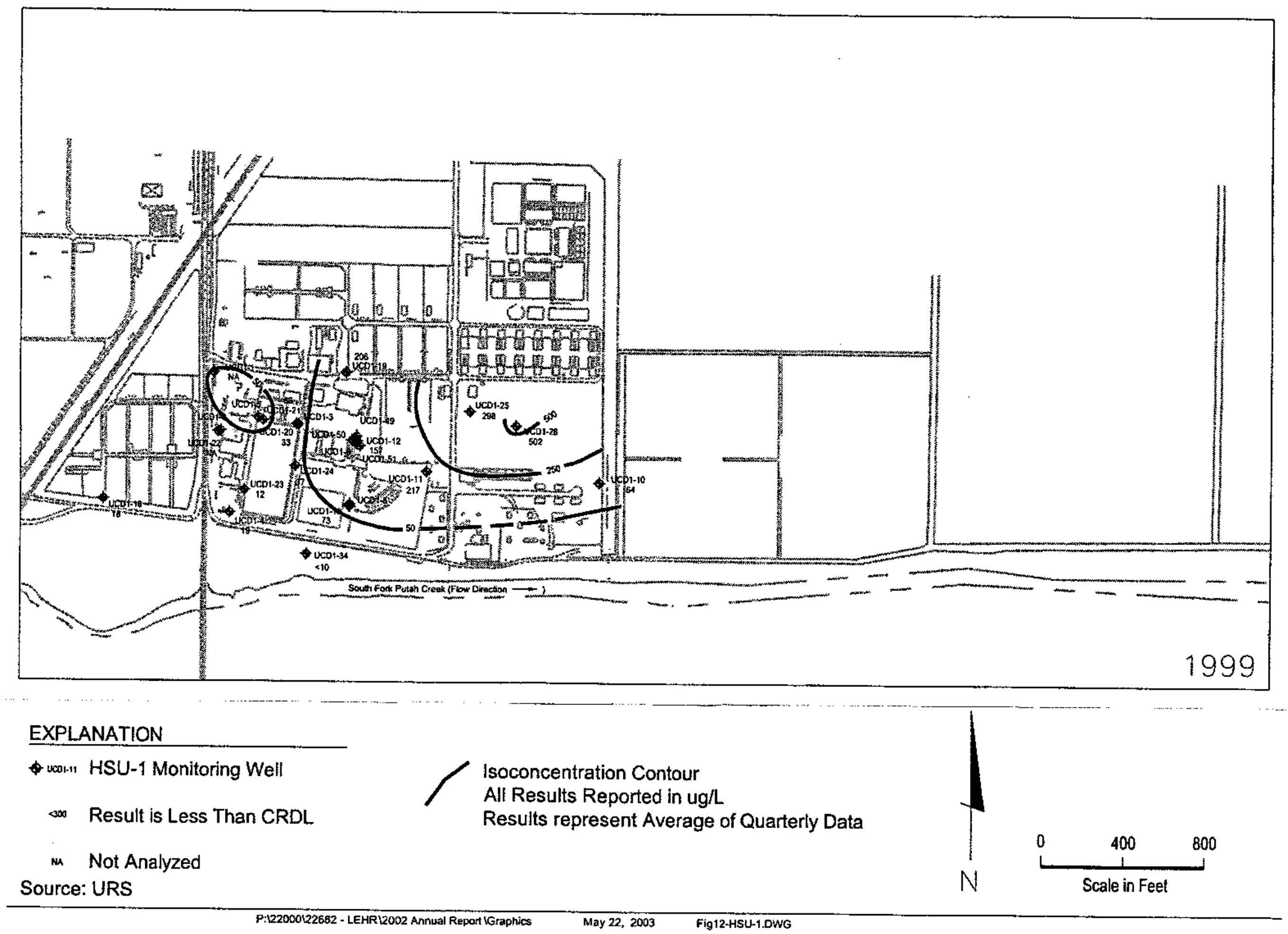
The following LEHR Project personnel worked on the 2002 Annual Site Environmental Report:

Name and Position	Responsibility
Michael Dresen LEHR Program Manager, Weiss Associates	Senior guidance, review, and quality assurance
Robert Devany LEHR Project Manager, Weiss Associates	Project management, technical guidance and review
Agata Sulczynski, LEHR Regulatory Compliance Manager, Weiss Associates	Report preparation
Chris Lawless Project Scientist, Weiss Associates	Soil contamination and air quality data interpretation
Dolores Loll LEHR Quality Assurance Manager, Weiss Associates	Technical review and quality assurance
Craig Adams Graphics, Weiss Associates	Graphics
Candy Lund Project Administrator, Weiss Associates	Word processing and report coordination
Ted Trammel Production Personnel, Weiss Associates	Graphics and report production

APPENDIX A

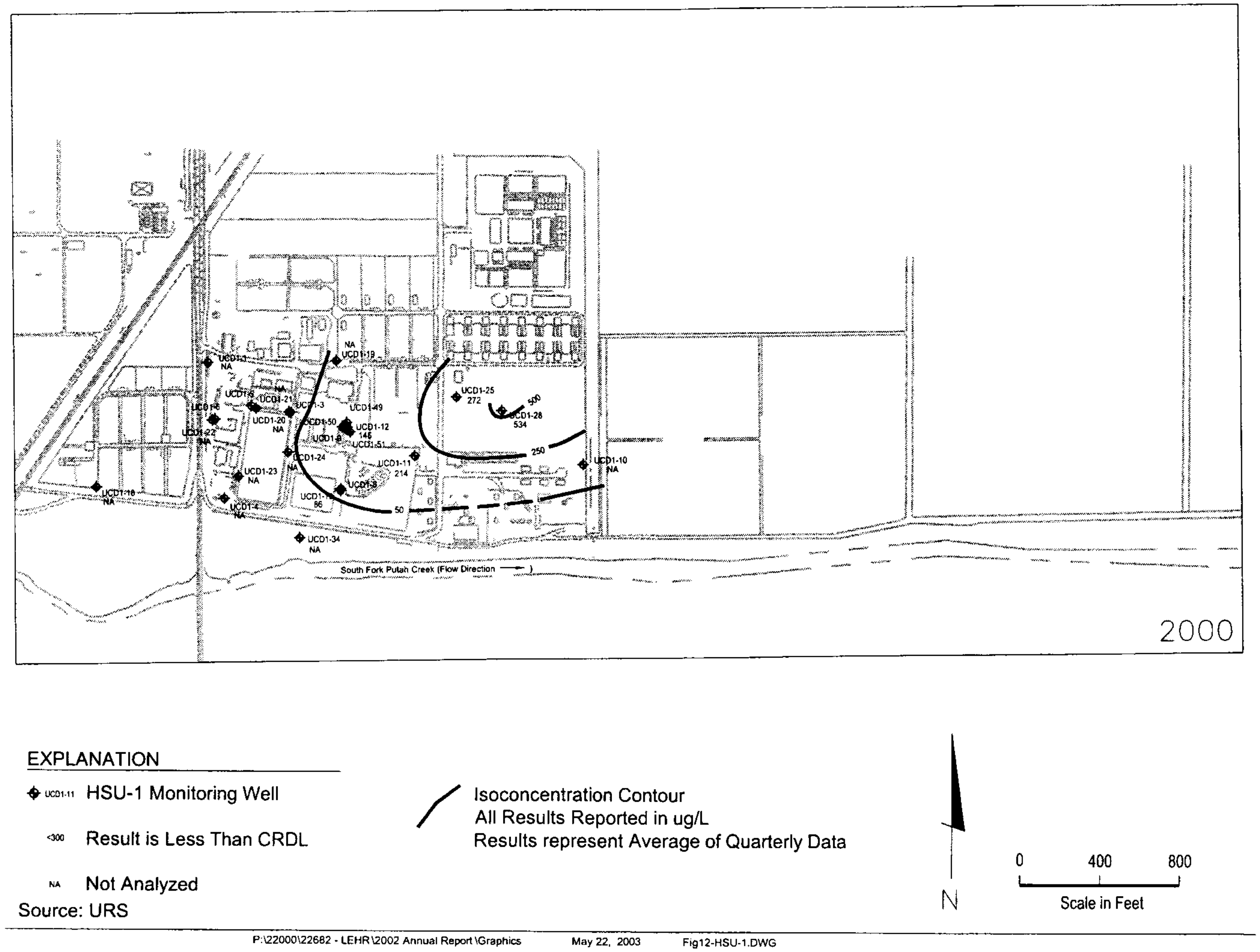
ISOCONCENTRATION MAPS
FOR HYDROSTRATIGRAPHIC UNITS 1 AND 2

CHROMIUM ISOCONCENTRATION CONTOURS IN HSU-1, 1999



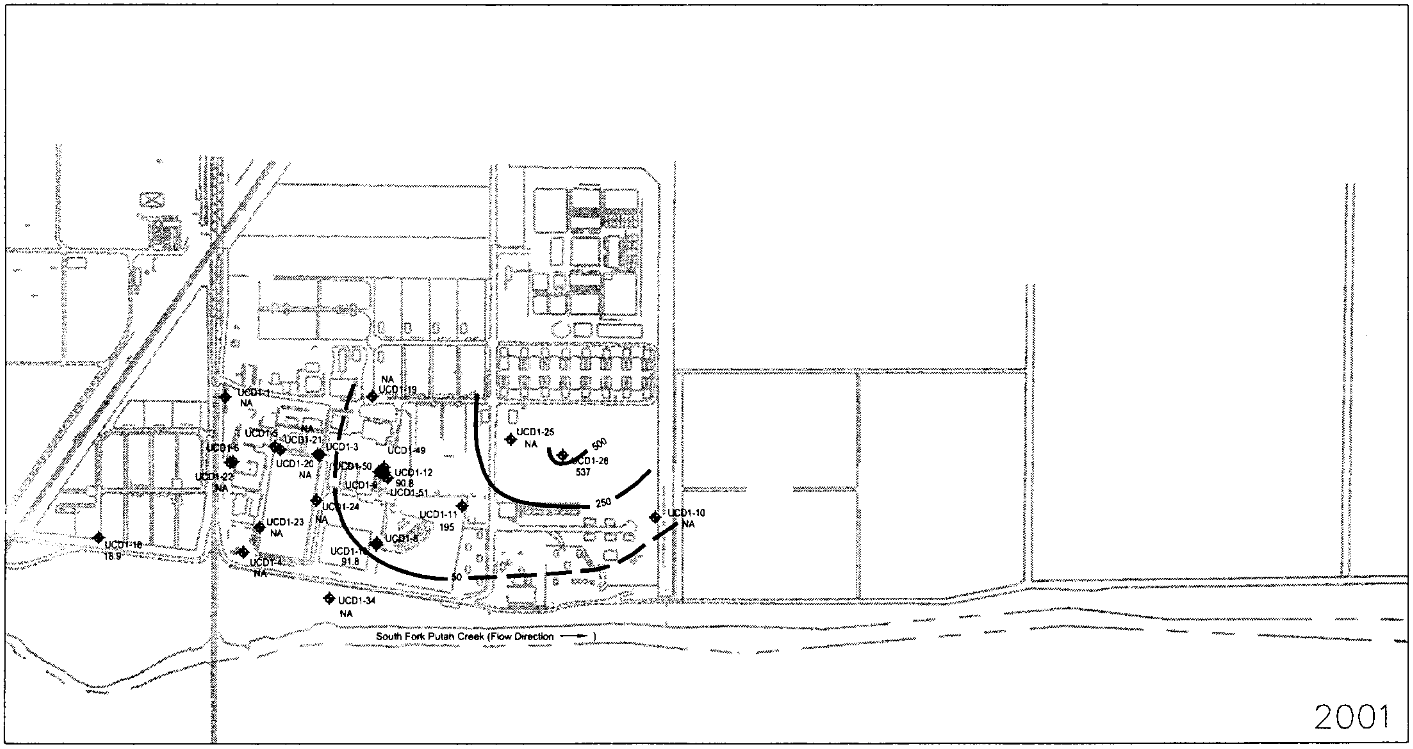
NOTE: BASE MAP FROM BROWN AND CALDWELL

CHROMIUM ISOCONCENTRATION CONTOURS IN HSU-1, 2000



NOTE: BASE MAP FROM BROWN AND CALDWELL

CHROMIUM ISOCONCENTRATION CONTOURS IN HSU-1, 2001



EXPLANATION

UCD1-11 HSU-1 Monitoring Well

<300 Result is Less Than CRDL

NA Not Analyzed

Source: URS

Isoconcentration Contour
All Results Reported in ug/L
Results represent Average of Quarterly Data

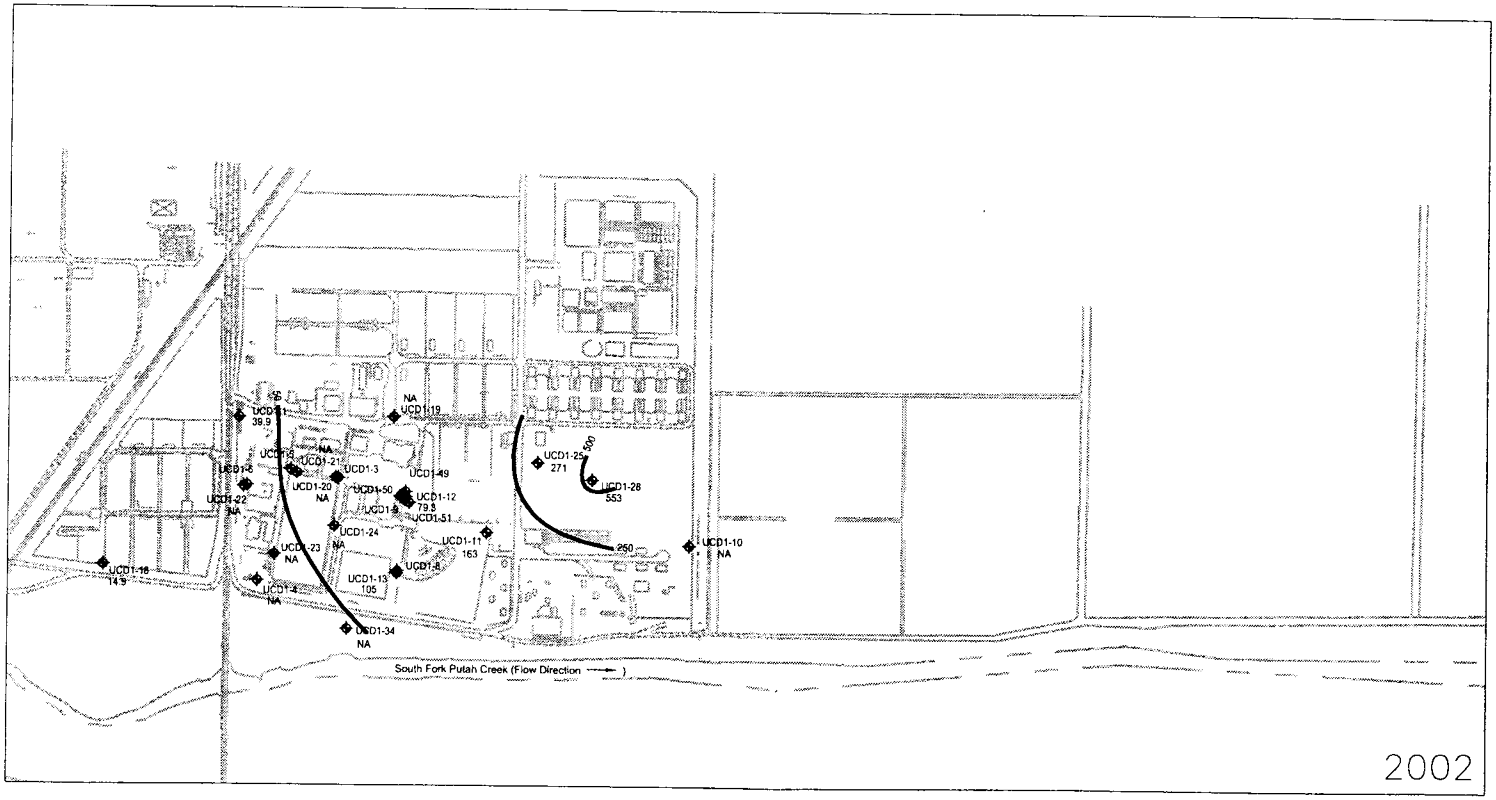
N

0 400 800
Scale in Feet

P:\22000\22682 - LEHR\2002 Annual Report\Graphics May 22, 2003 Fig12-HSU-1.DWG

NOTE: BASE MAP FROM BROWN AND CALDWELL

CHROMIUM ISOCONCENTRATION CONTOURS IN HSU-1, 2002



EXPLANATION

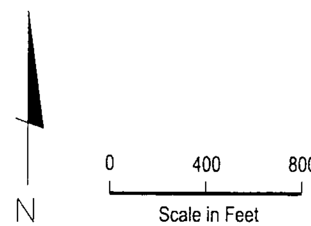
UCD1-11 HSU-1 Monitoring Well

<300 Result is Less Than CRDL

NA Not Analyzed

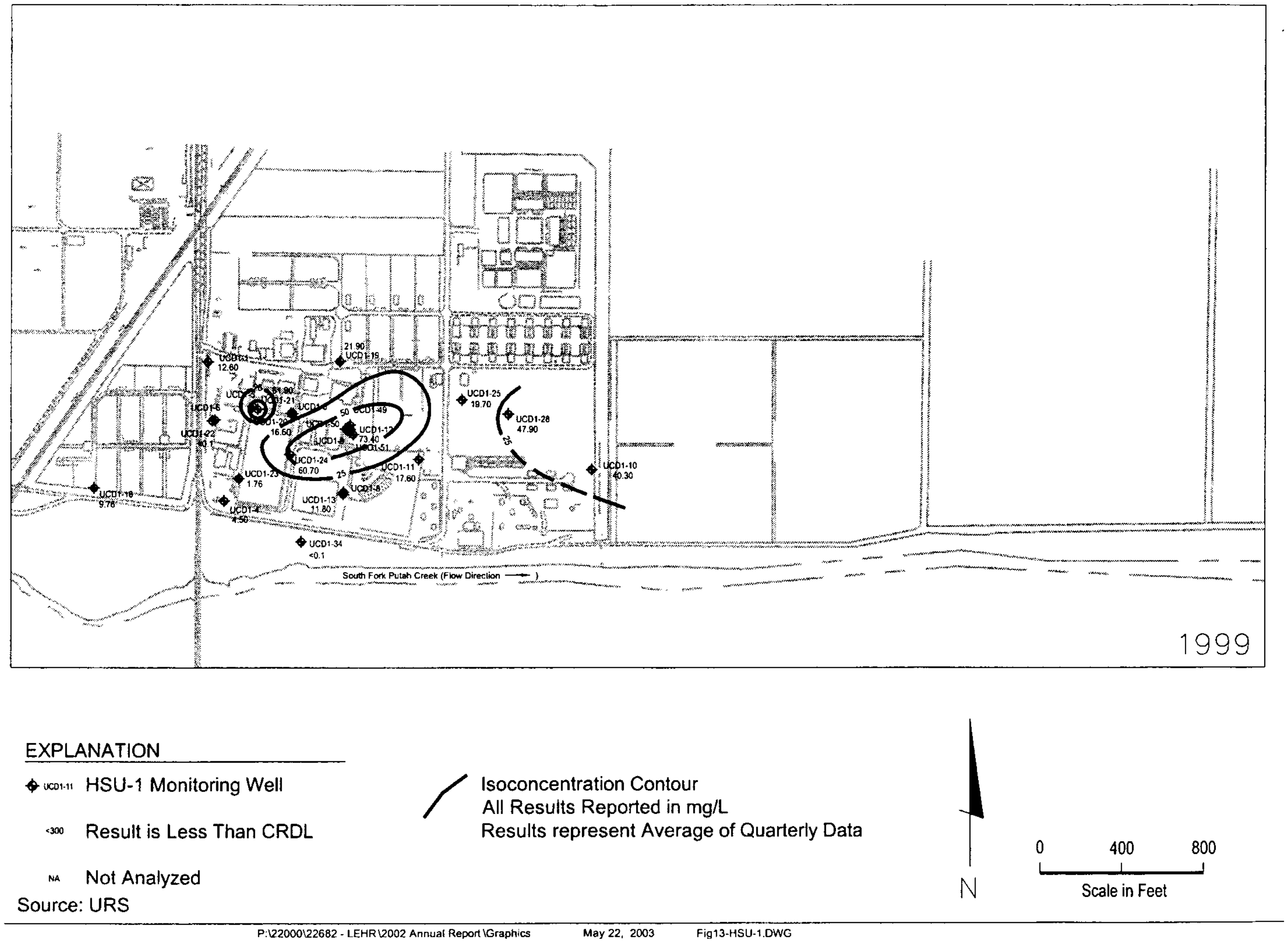
Source: URS

Isoconcentration Contour
All Results Reported in ug/L
Results represent Average of Quarterly Data



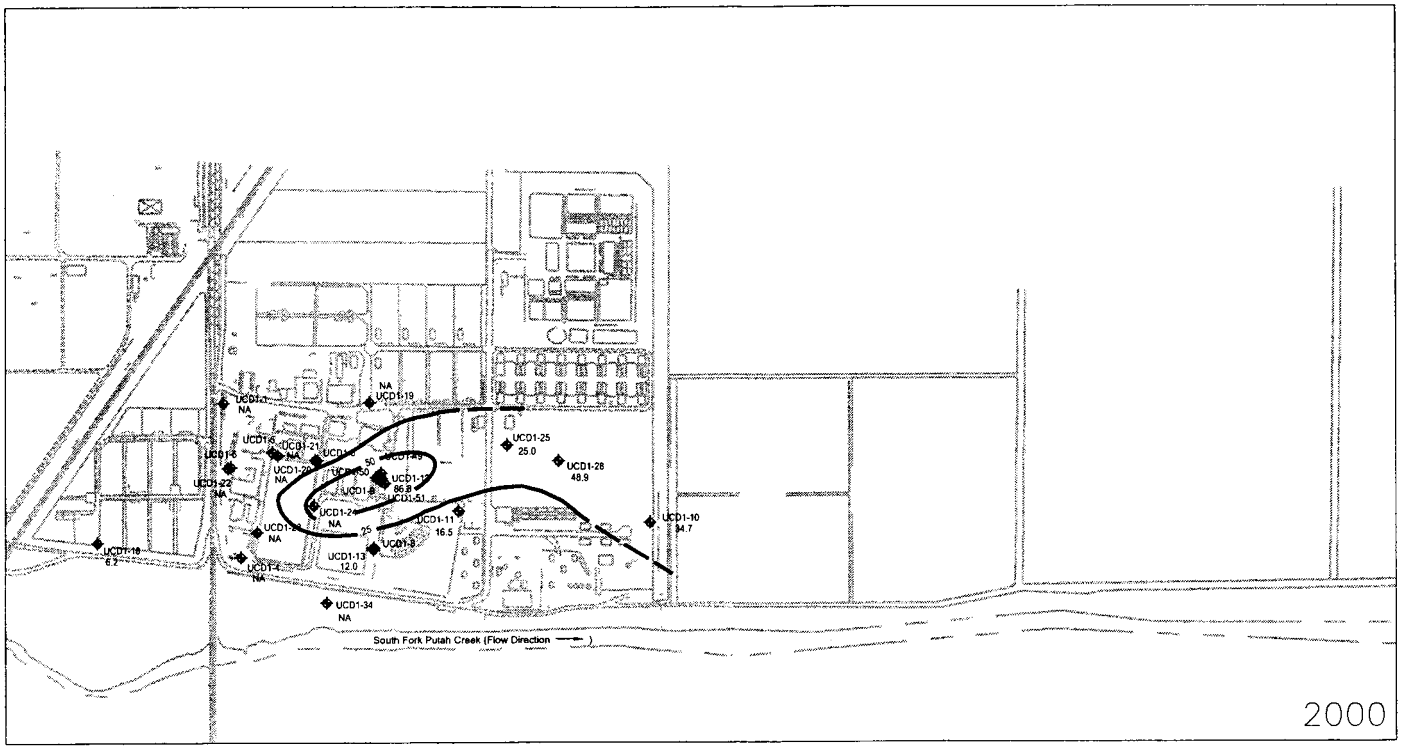
NOTE: BASE MAP FROM BROWN AND CALDWELL

NITRATE AS N ISOCONCENTRATION CONTOURS IN HSU-1, 1999



NOTE: BASE MAP FROM BROWN AND CALDWELL

NITRATE AS N ISOCONCENTRATION CONTOURS IN HSU-1, 2000



EXPLANATION

UCD1-11 HSU-1 Monitoring Well

<300 Result is Less Than CRDL

NA Not Analyzed

Isoconcentration Contour
All Results Reported in mg/L
Results represent Average of Quarterly Data

N

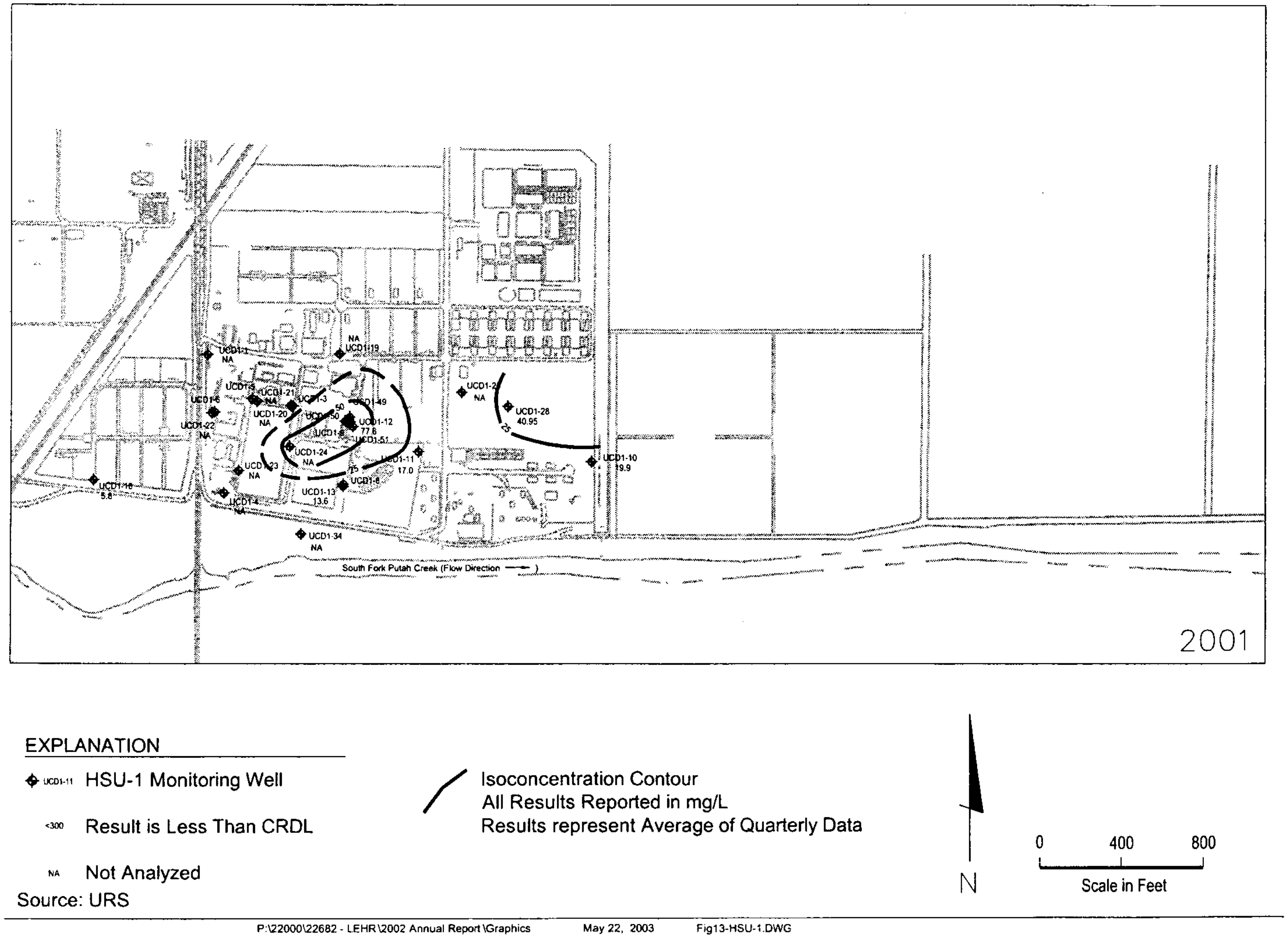
0 400 800
Scale in Feet

Source: URS

P:\22000\22682 - LEHR\2002 Annual Report\Graphics May 22, 2003 Fig13-HSU-1.DWG

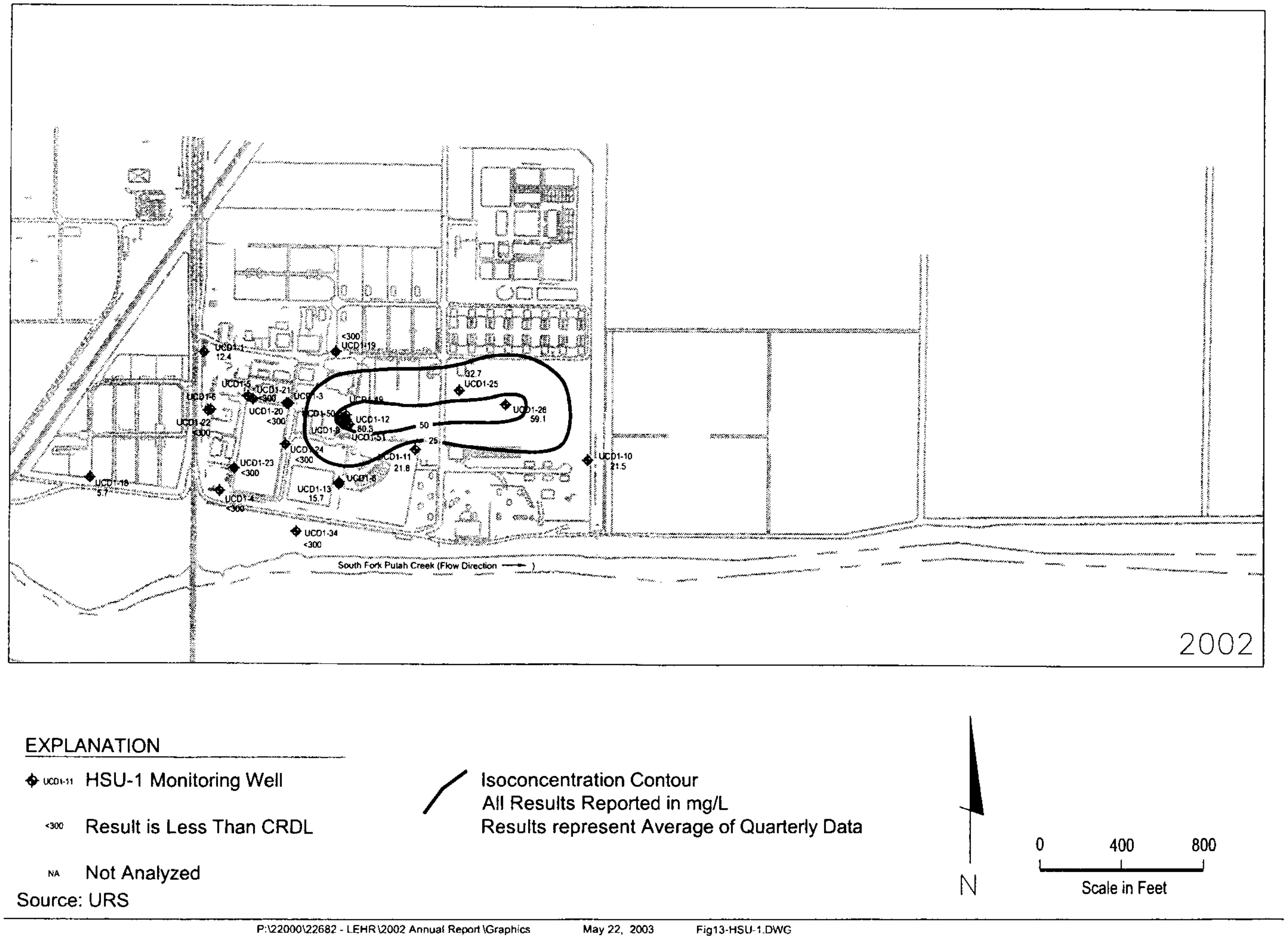
NOTE: BASE MAP FROM BROWN AND CALDWELL

NITRATE AS N ISOCONCENTRATION CONTOURS IN HSU-1, 2001



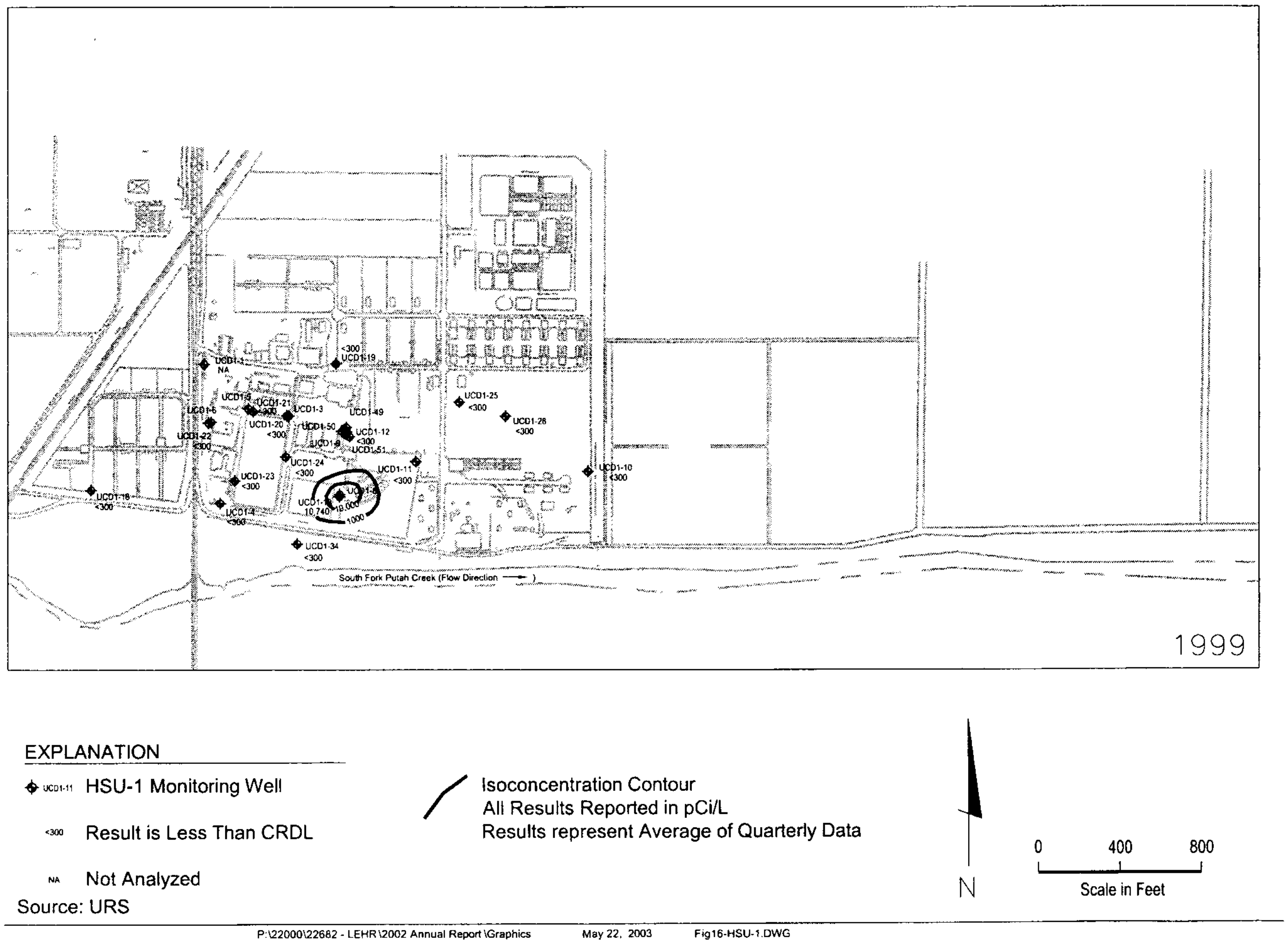
NOTE: BASE MAP FROM BROWN AND CALDWELL

NITRATE AS N ISOCONCENTRATION CONTOURS IN HSU-1, 2002



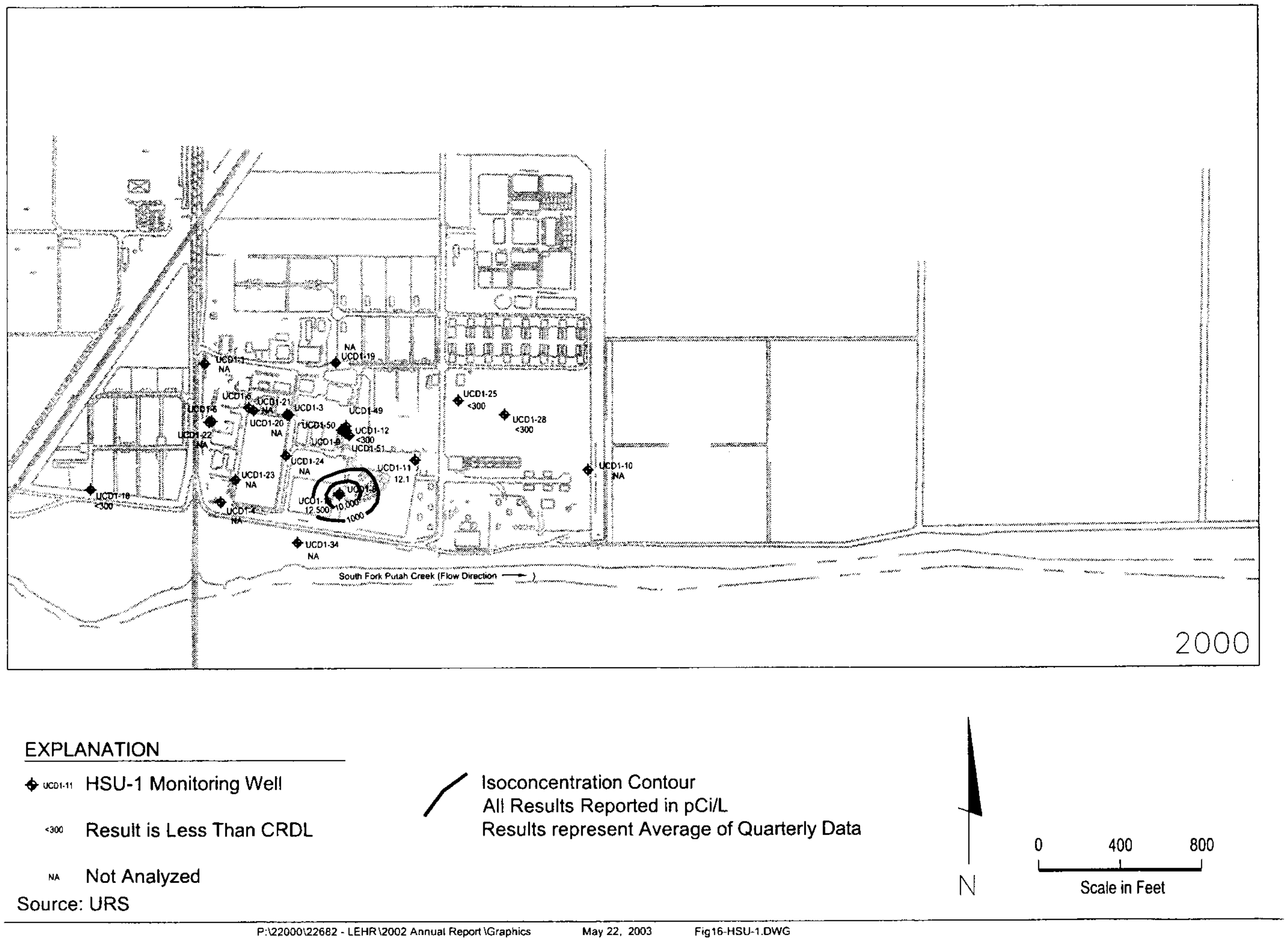
NOTE: BASE MAP FROM BROWN AND CALDWELL

TRITIUM ISOCONCENTRATION CONTOURS IN HSU-1, 1999



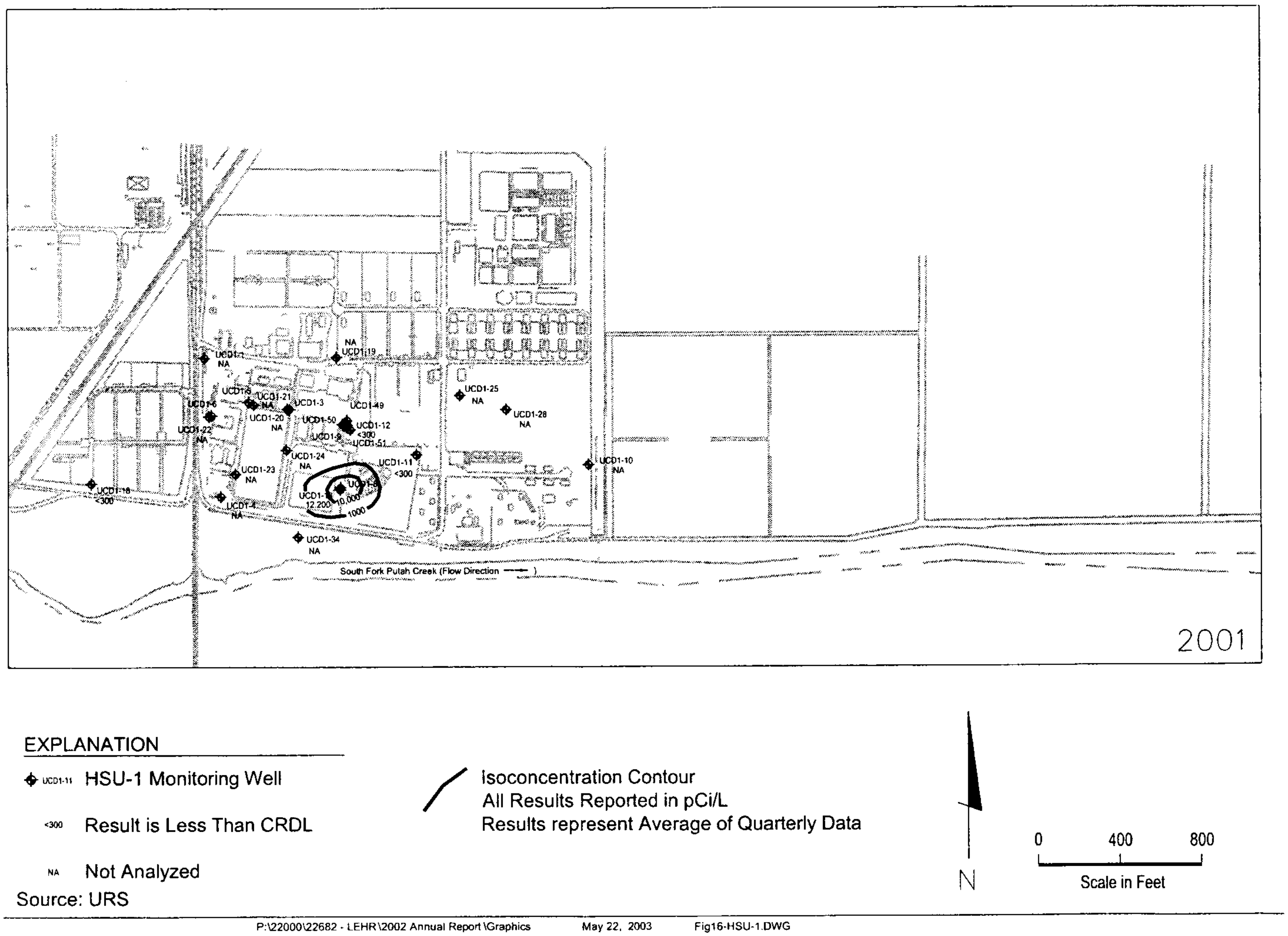
NOTE: BASE MAP FROM BROWN AND CALDWELL

TRITIUM ISOCONCENTRATION CONTOURS IN HSU-1, 2000



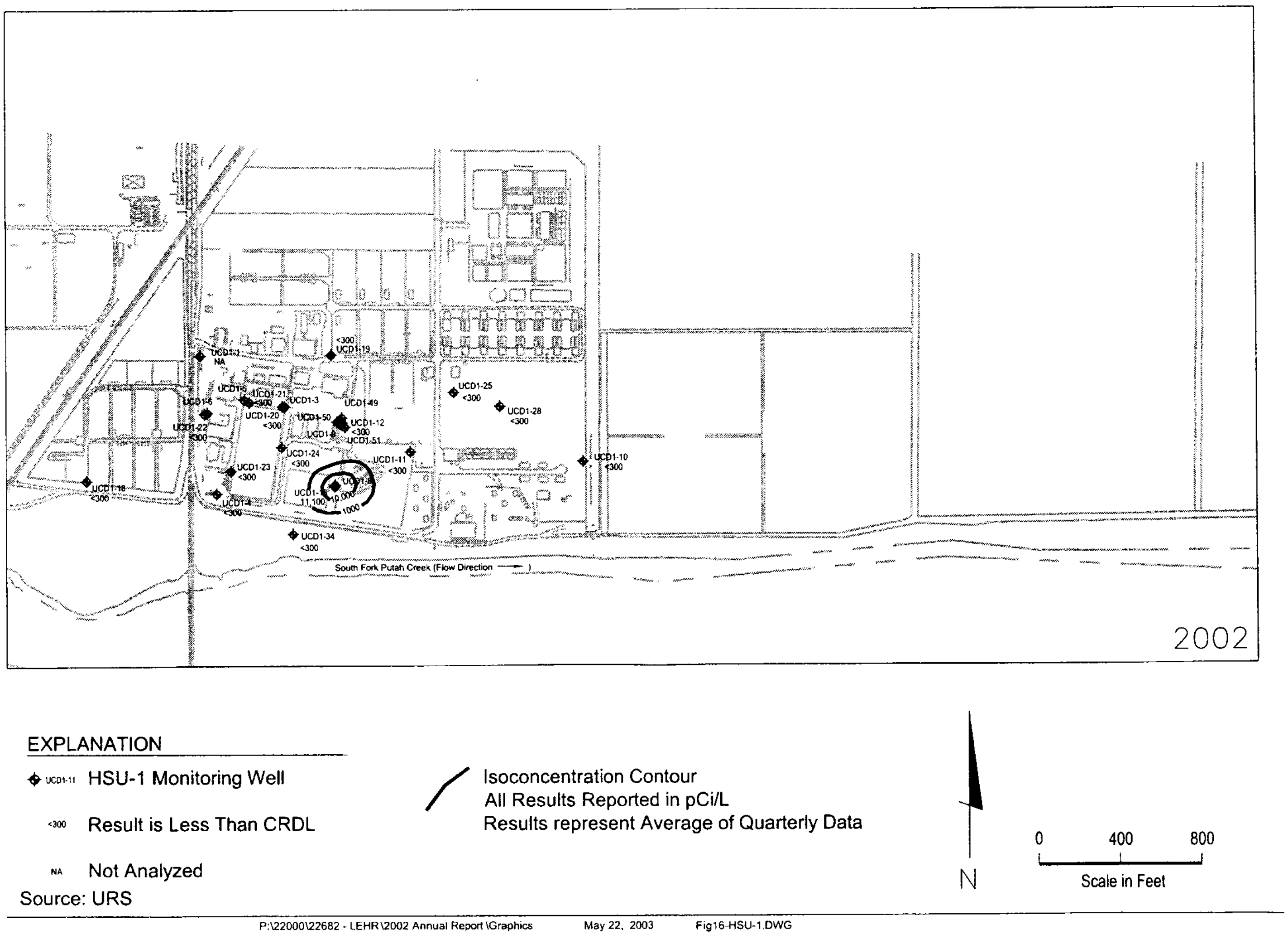
NOTE: BASE MAP FROM BROWN AND CALDWELL

TRITIUM ISOCONCENTRATION CONTOURS IN HSU-1, 2001



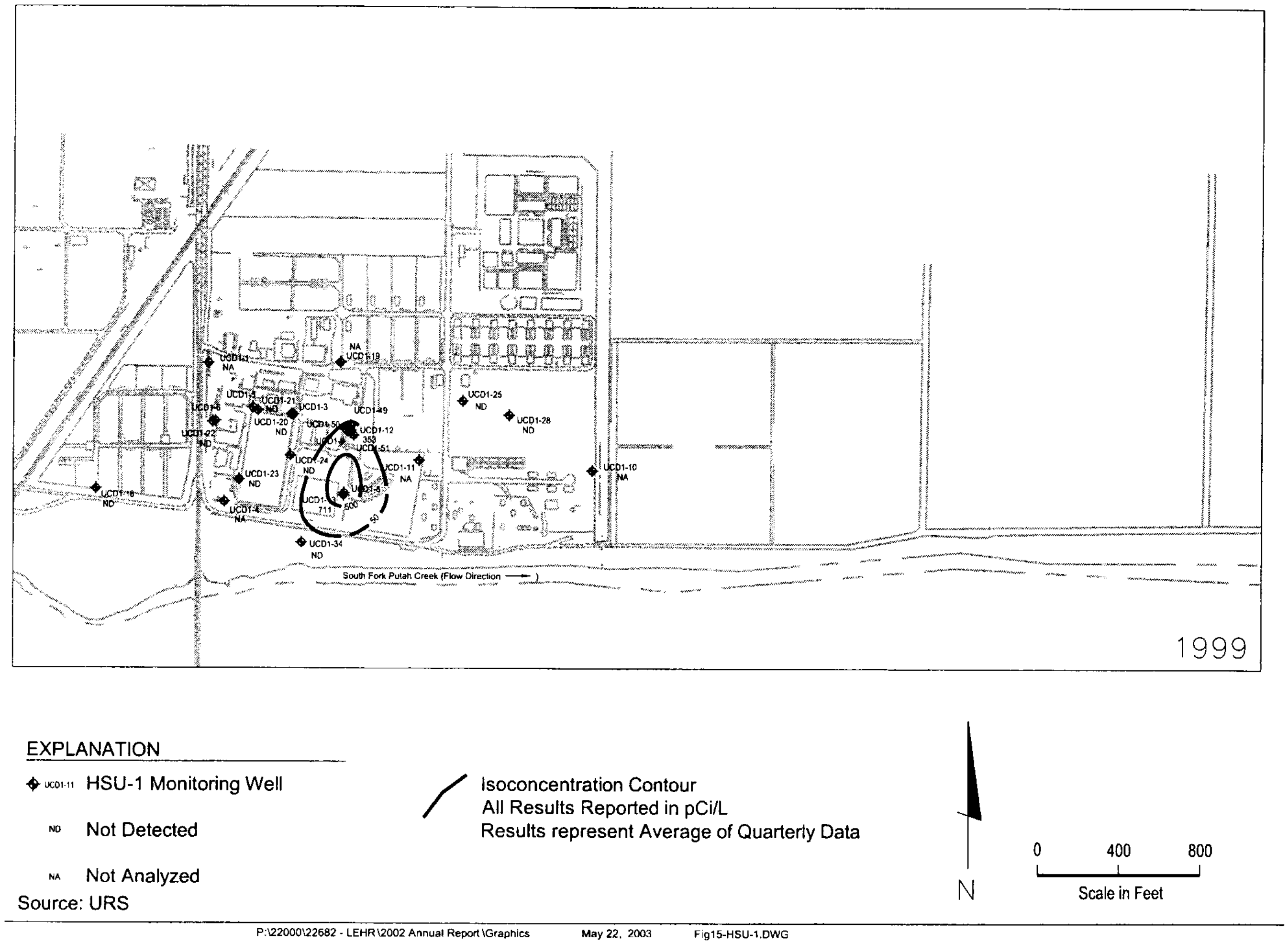
NOTE: BASE MAP FROM BROWN AND CALDWELL

TRITIUM ISOCONCENTRATION CONTOURS IN HSU-1, 2002



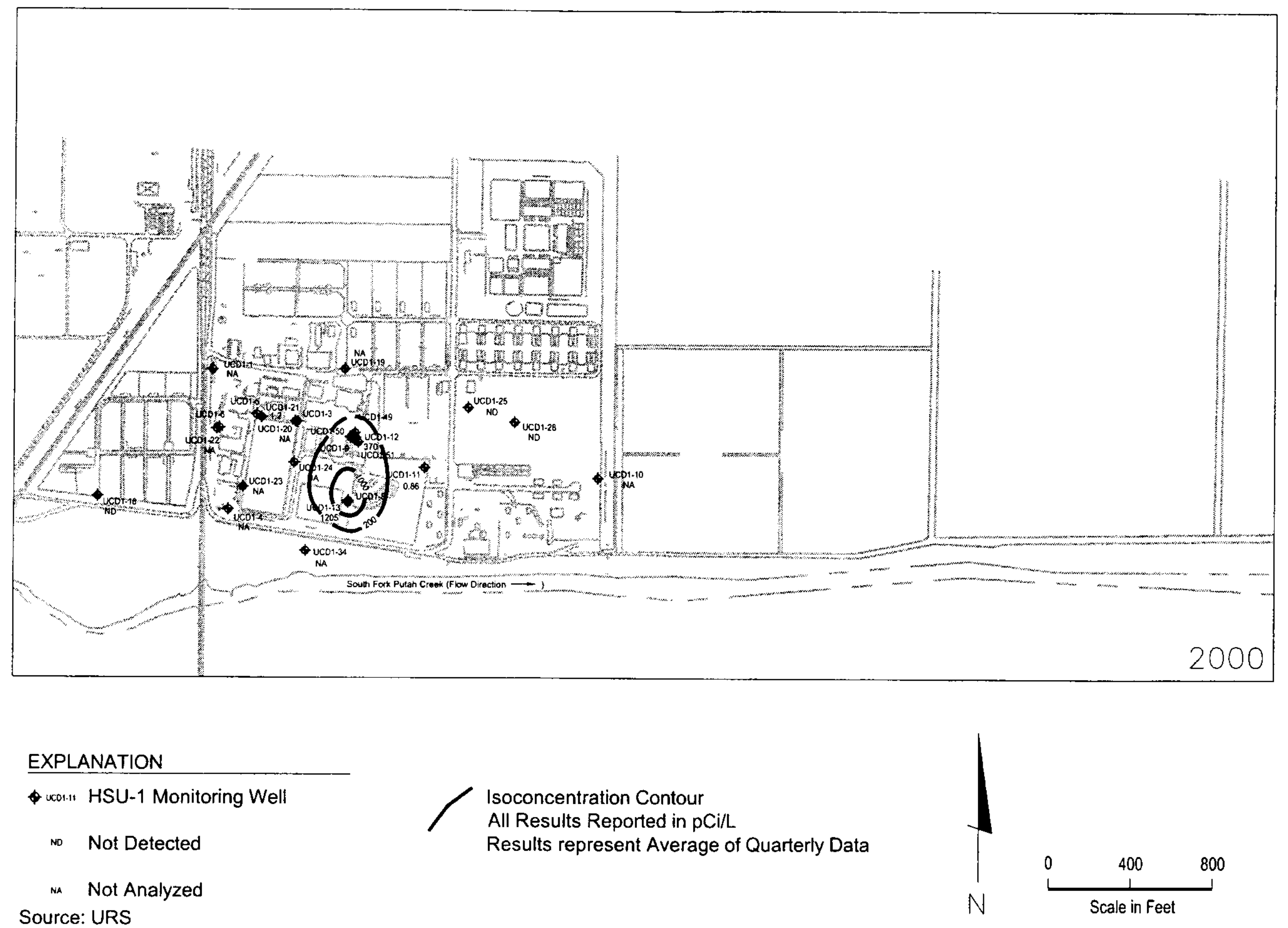
NOTE: BASE MAP FROM BROWN AND CALDWELL

CARBON-14 ISOCONCENTRATION CONTOURS IN HSU-1, 1999



NOTE: BASE MAP FROM BROWN AND CALDWELL

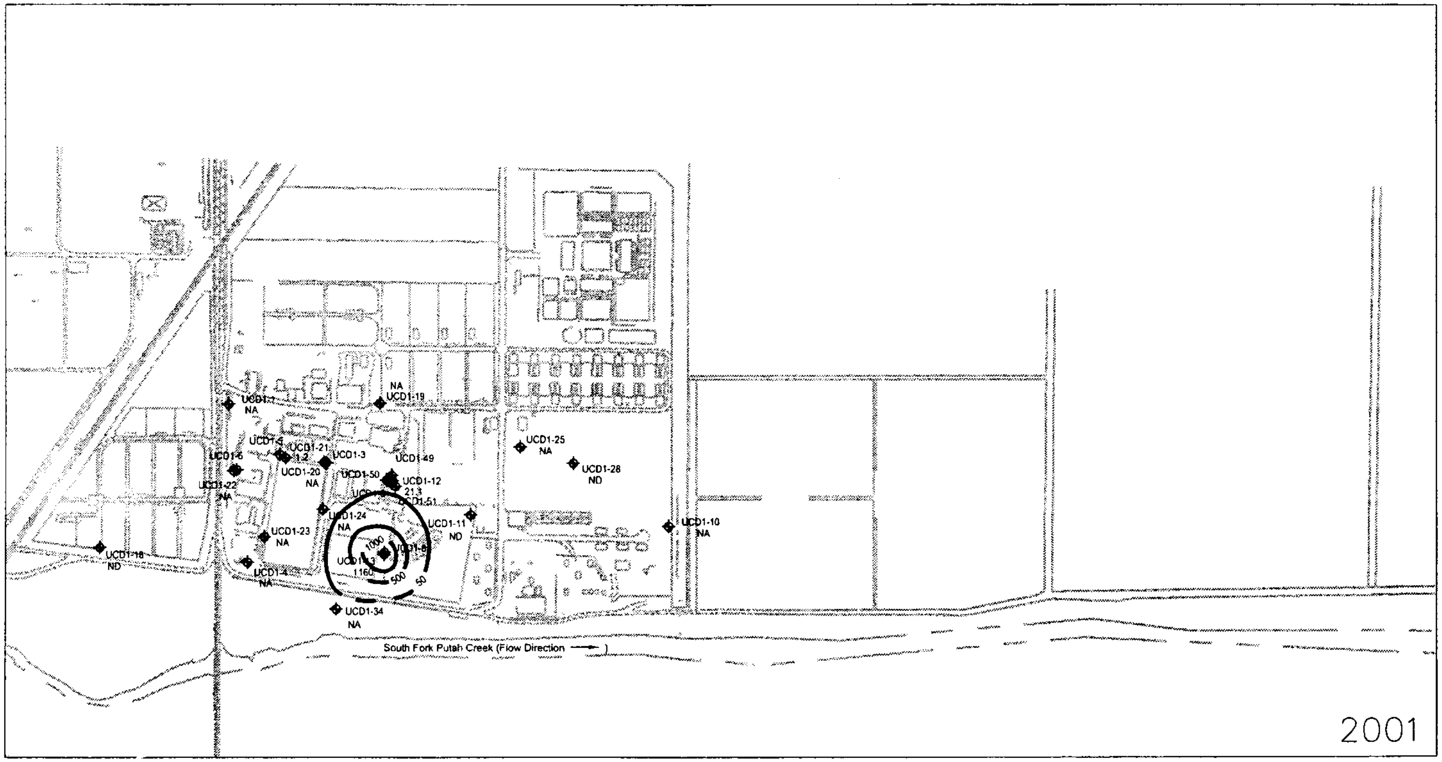
CARBON-14 ISOCONCENTRATION CONTOURS IN HSU-1, 2000



P:\22000\22682 - LEHR\2002 Annual Report\Graphics May 22, 2003 Fig15-HSU-1.DWG

NOTE: BASE MAP FROM BROWN AND CALDWELL

CARBON-14 ISOCONCENTRATION CONTOURS IN HSU-1, 2001



EXPLANATION

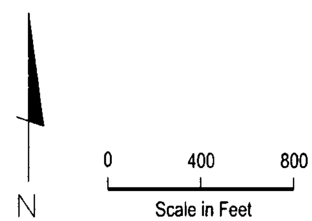
UCD1-11 HSU-1 Monitoring Well

ND Not Detected

NA Not Analyzed

Isoconcentration Contour
All Results Reported in pCi/L
Results represent Average of Quarterly Data

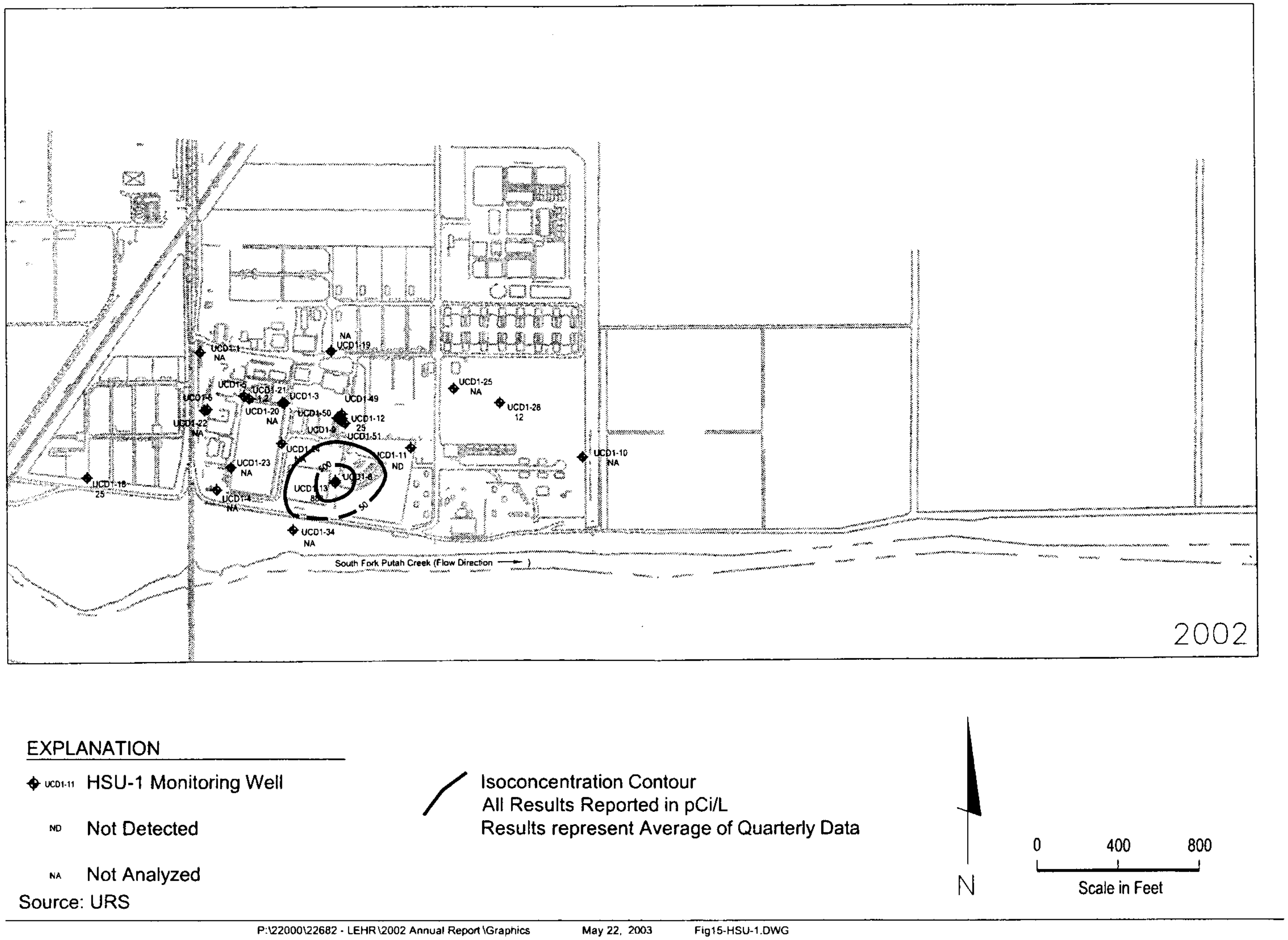
Source: URS



P:\22000\22682 - LEHR\2002 Annual Report\Graphics May 22, 2003 Fig15-HSU-1.DWG

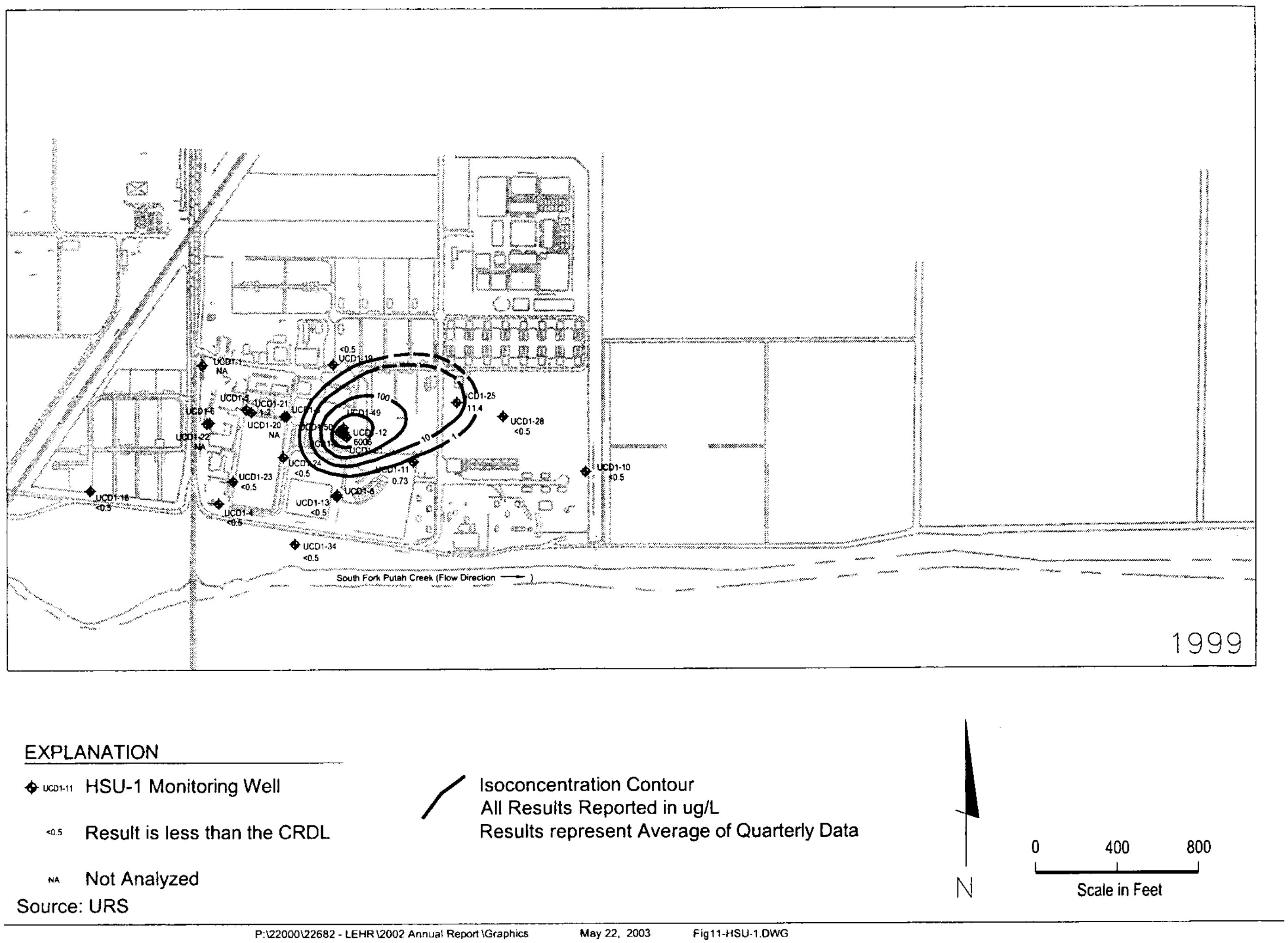
NOTE: BASE MAP FROM BROWN AND CALDWELL

CARBON-14 ISOCONCENTRATION CONTOURS IN HSU-1, 2002



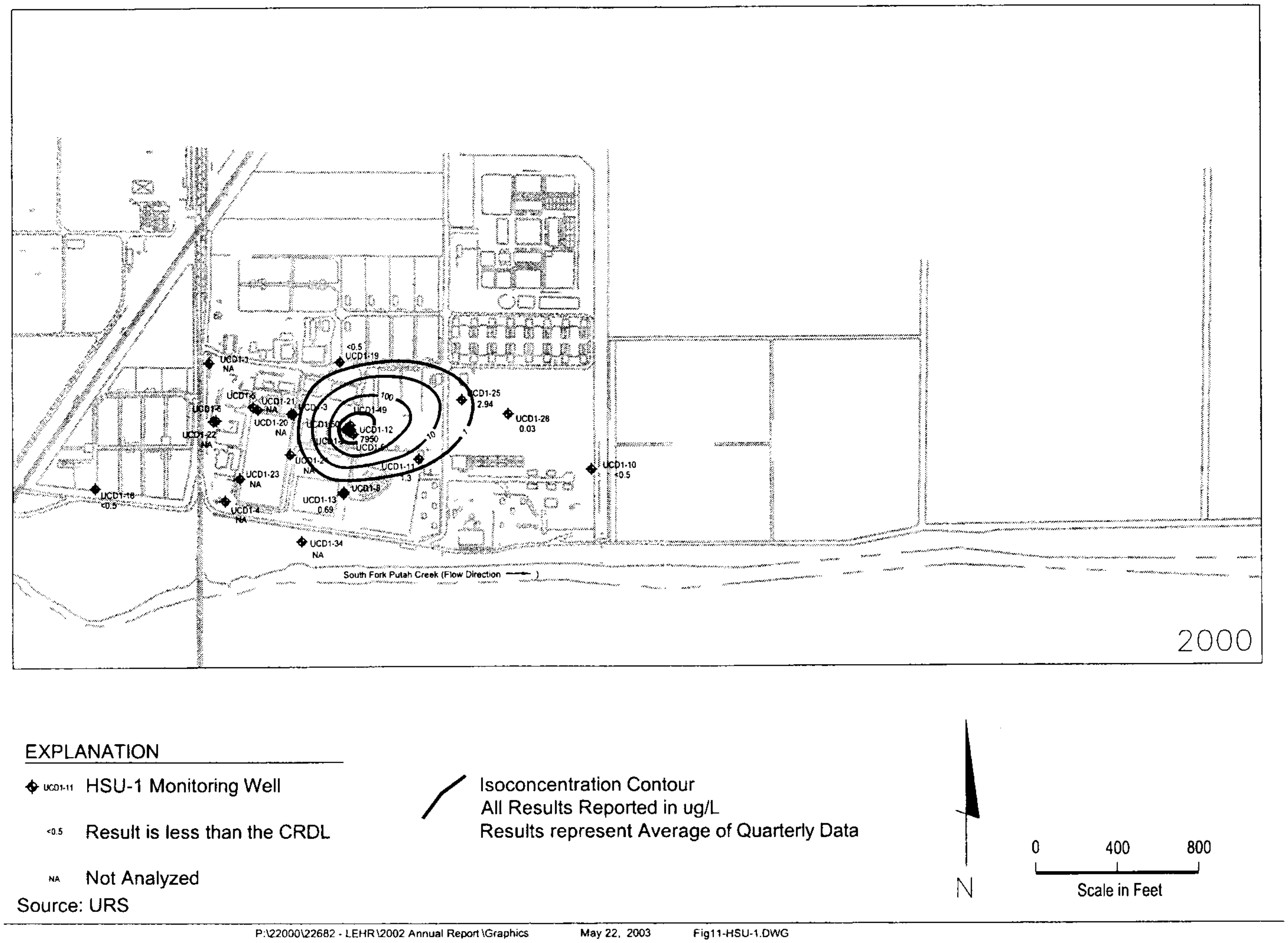
NOTE: BASE MAP FROM BROWN AND CALDWELL

CHLOROFORM ISOCONCENTRATION CONTOURS IN HSU-1, 1999



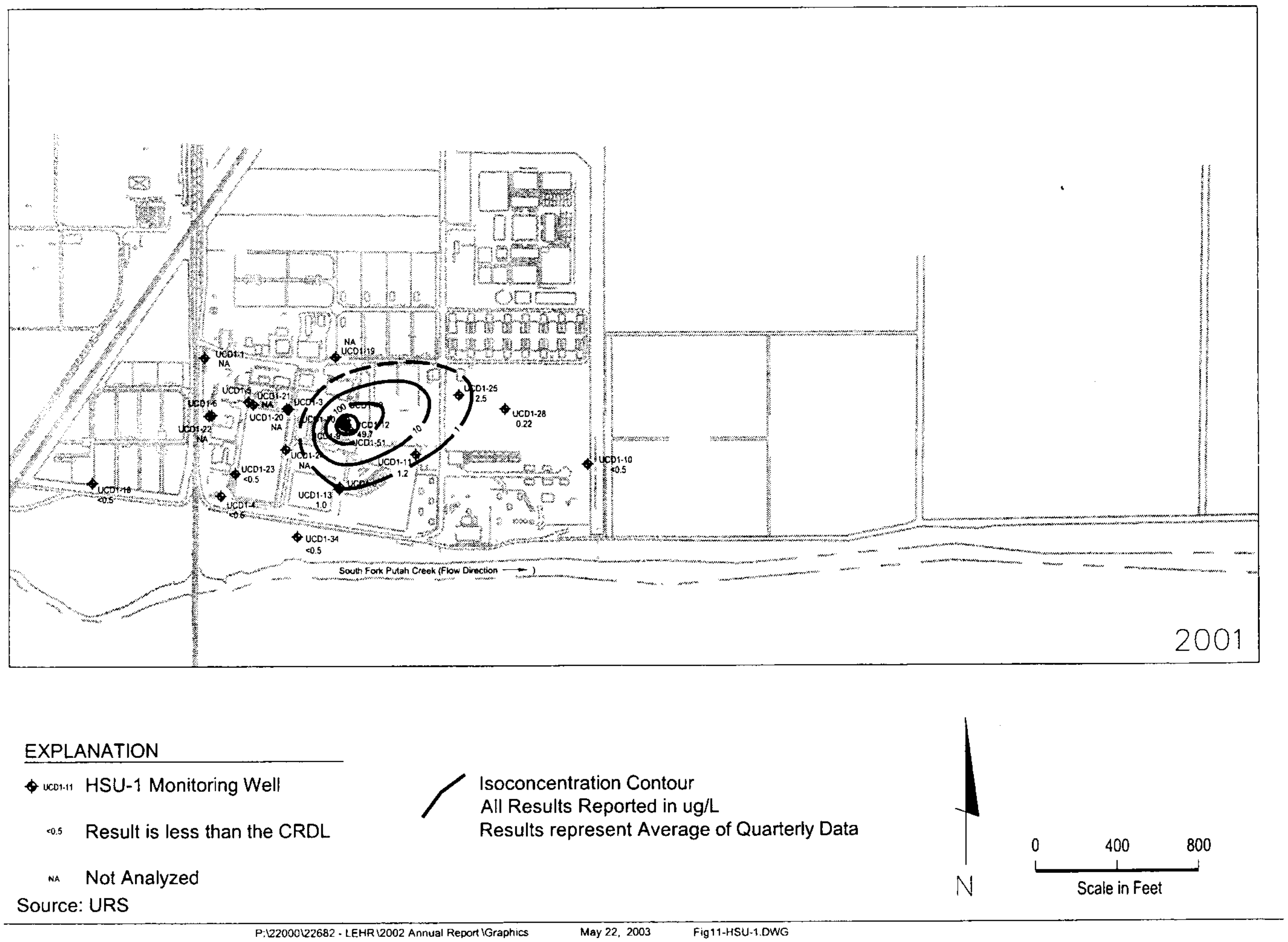
NOTE: BASE MAP FROM BROWN AND CALDWELL

CHLOROFORM ISOCONCENTRATION CONTOURS IN HSU-1, 2000



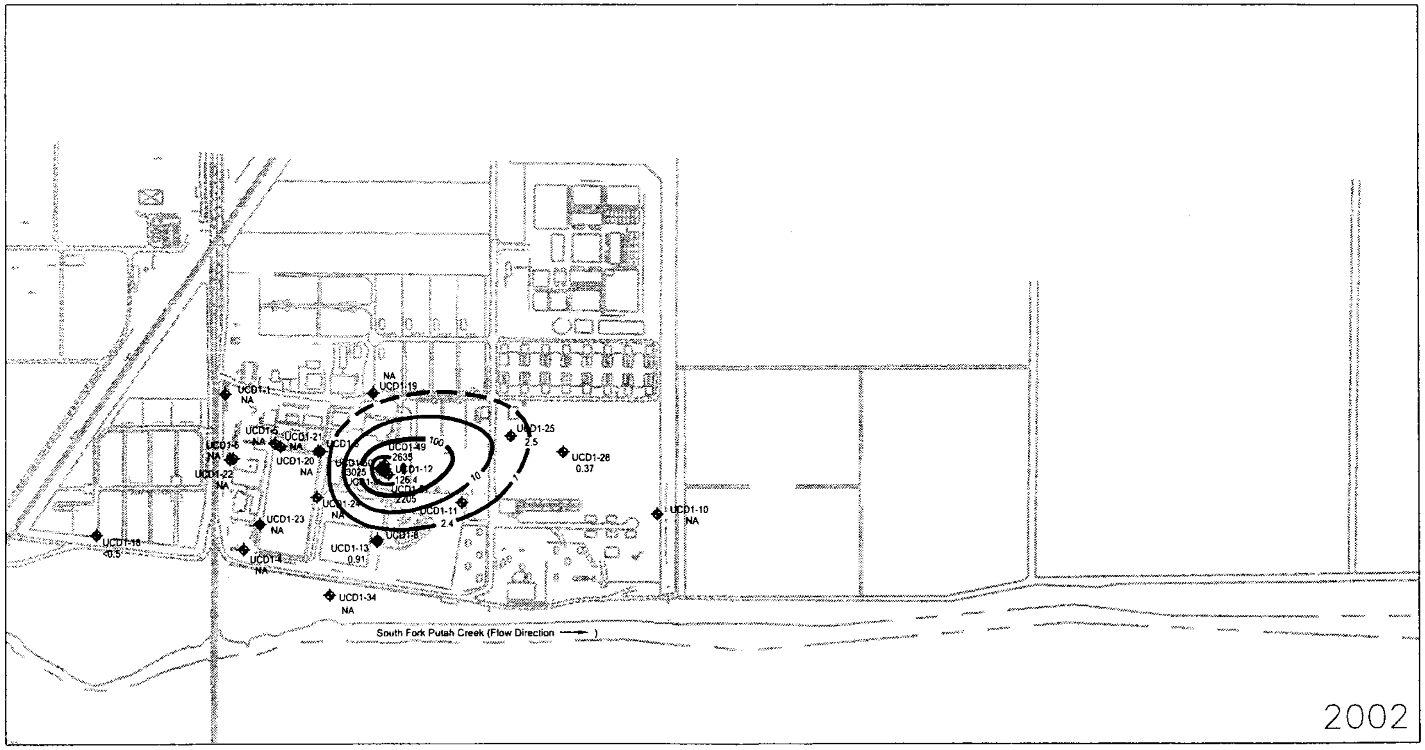
NOTE: BASE MAP FROM BROWN AND CALDWELL

CHLOROFORM ISOCONCENTRATION CONTOURS IN HSU-1, 2001



NOTE: BASE MAP FROM BROWN AND CALDWELL

CHLOROFORM ISOCONCENTRATION CONTOURS IN HSU-1, 2002



EXPLANATION

UCD1-11 HSU-1 Monitoring Well

<0.5 Result is less than the CRDL

NA Not Analyzed

Source: URS

Isoconcentration Contour
All Results Reported in ug/L
Results represent Average of Quarterly Data

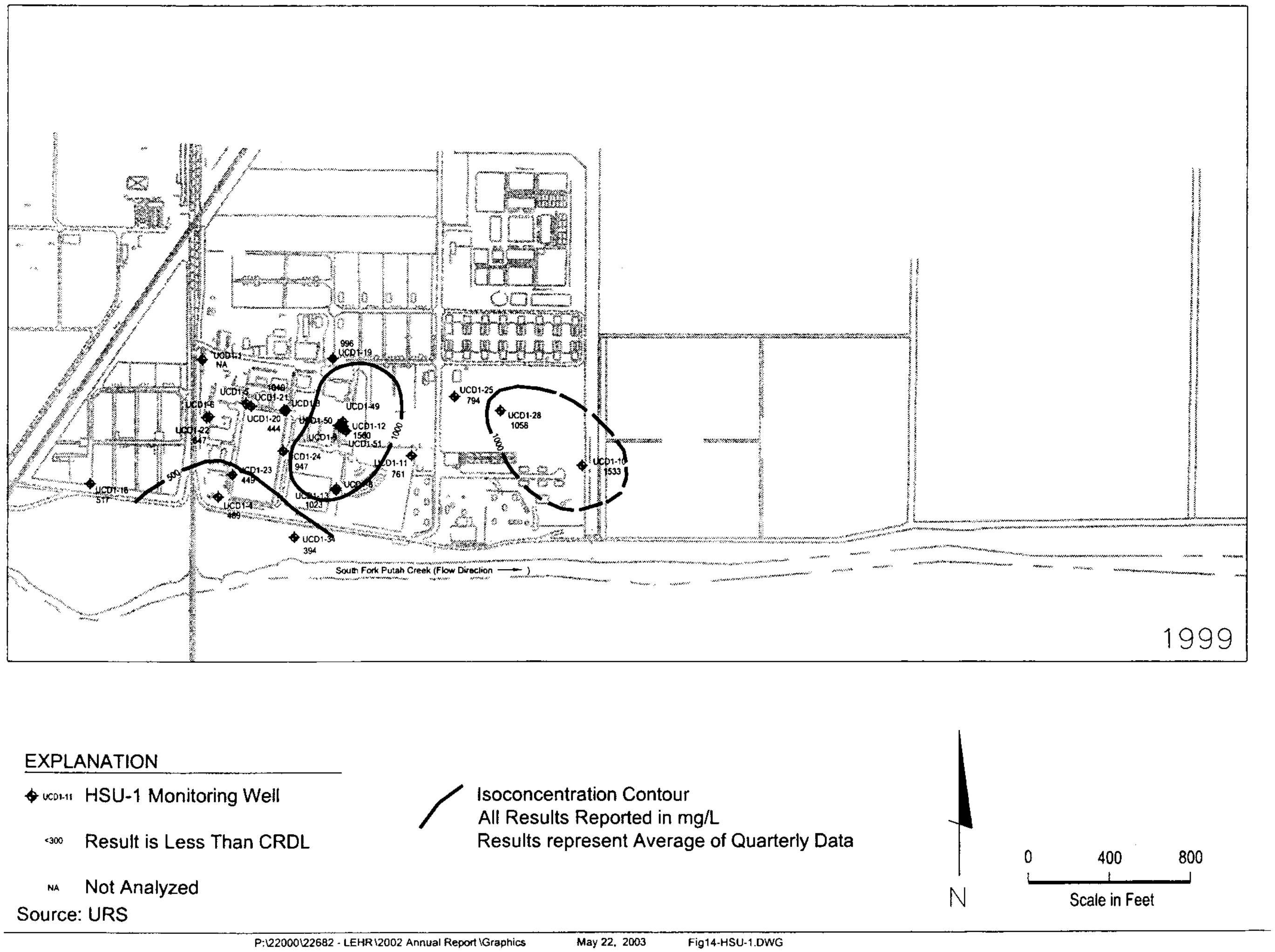
N

0 400 800
Scale in Feet

P:\22000\22682 - LEHR\2002 Annual Report\Graphics May 22, 2003 Fig11-HSU-1.DWG

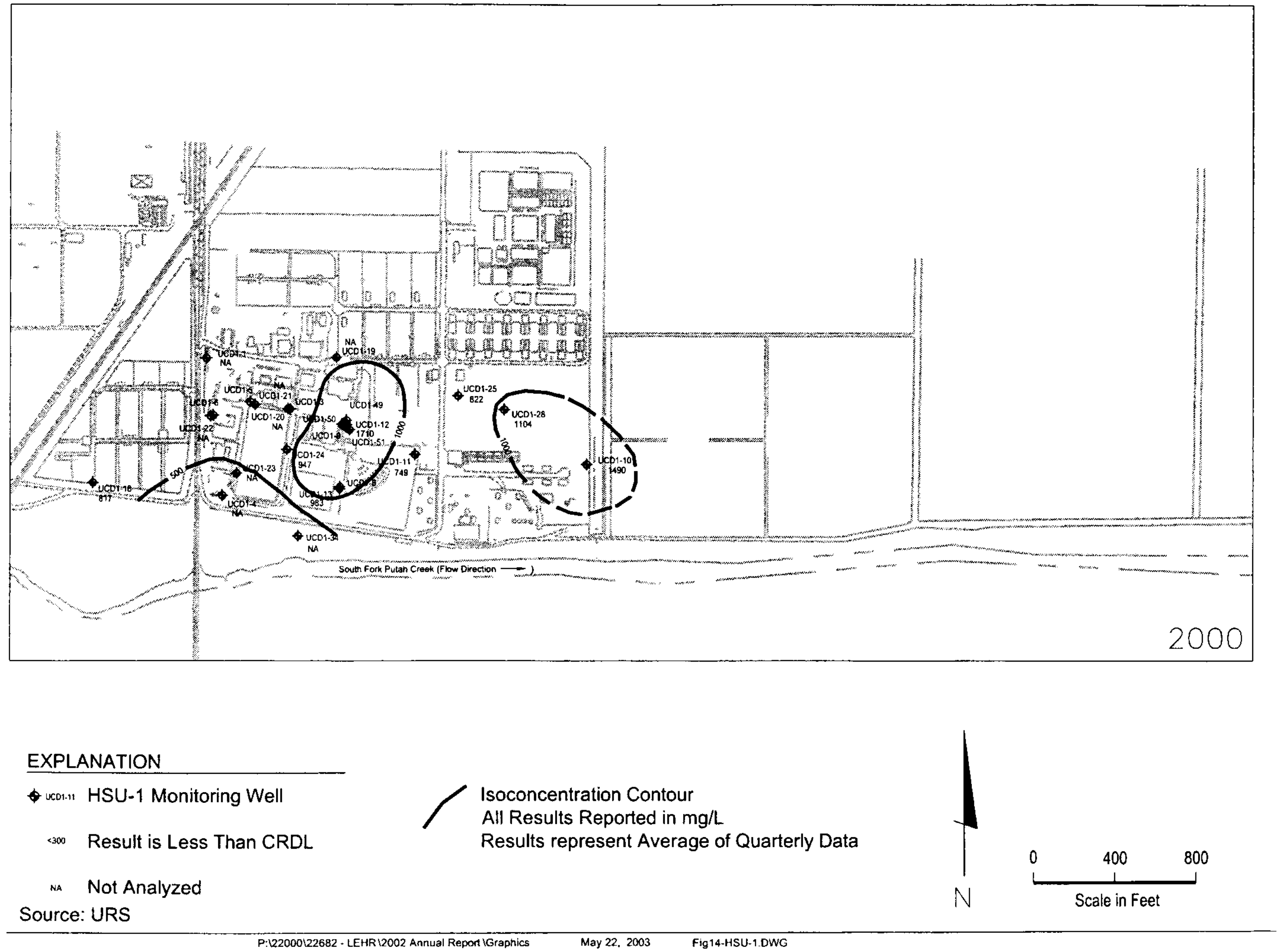
NOTE: BASE MAP FROM BROWN AND CALDWELL

TDS ISOCONCENTRATION CONTOURS IN HSU-1, 1999



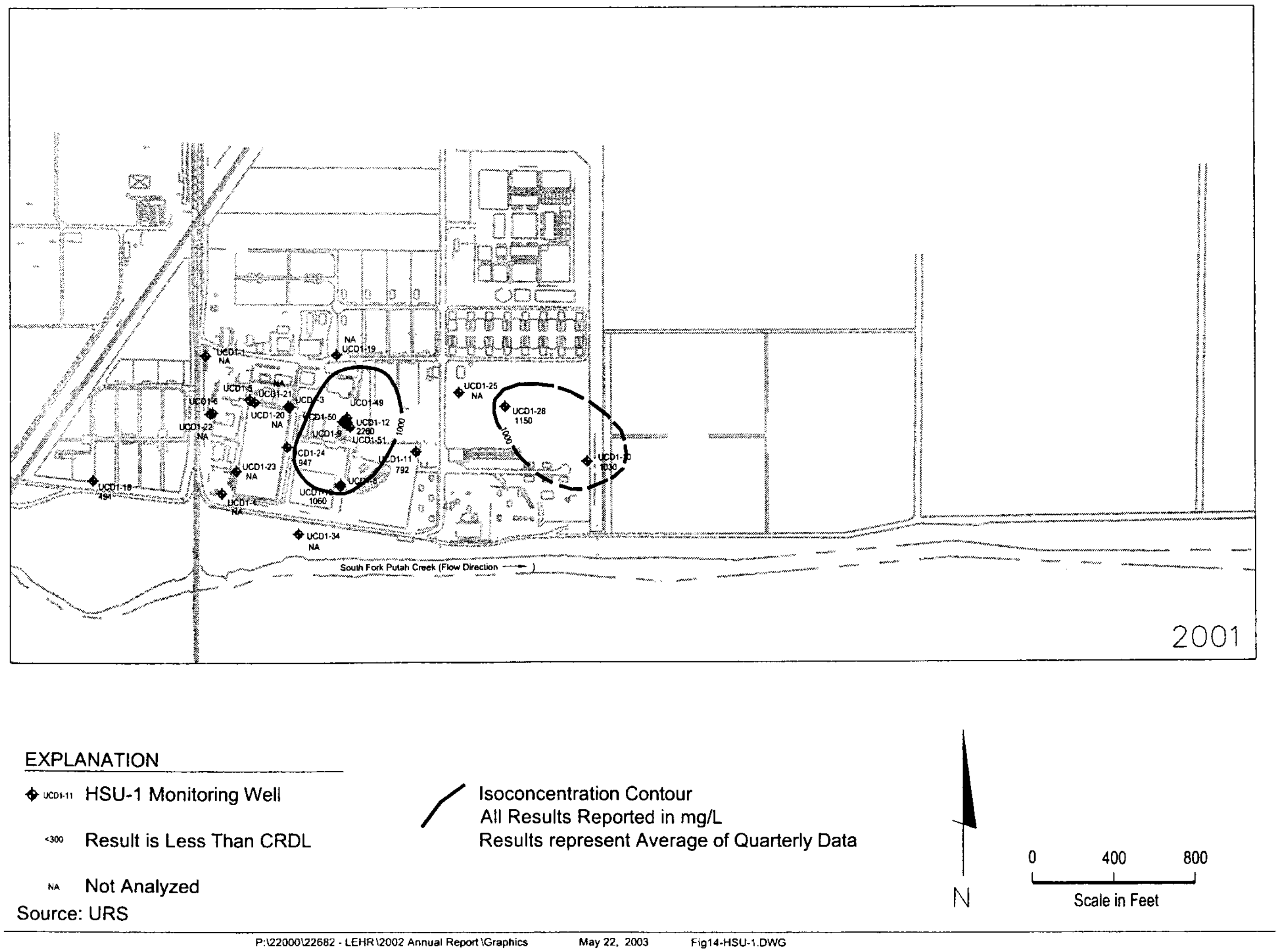
NOTE: BASE MAP FROM BROWN AND CALDWELL

TDS ISOCONCENTRATION CONTOURS IN HSU-1, 2000



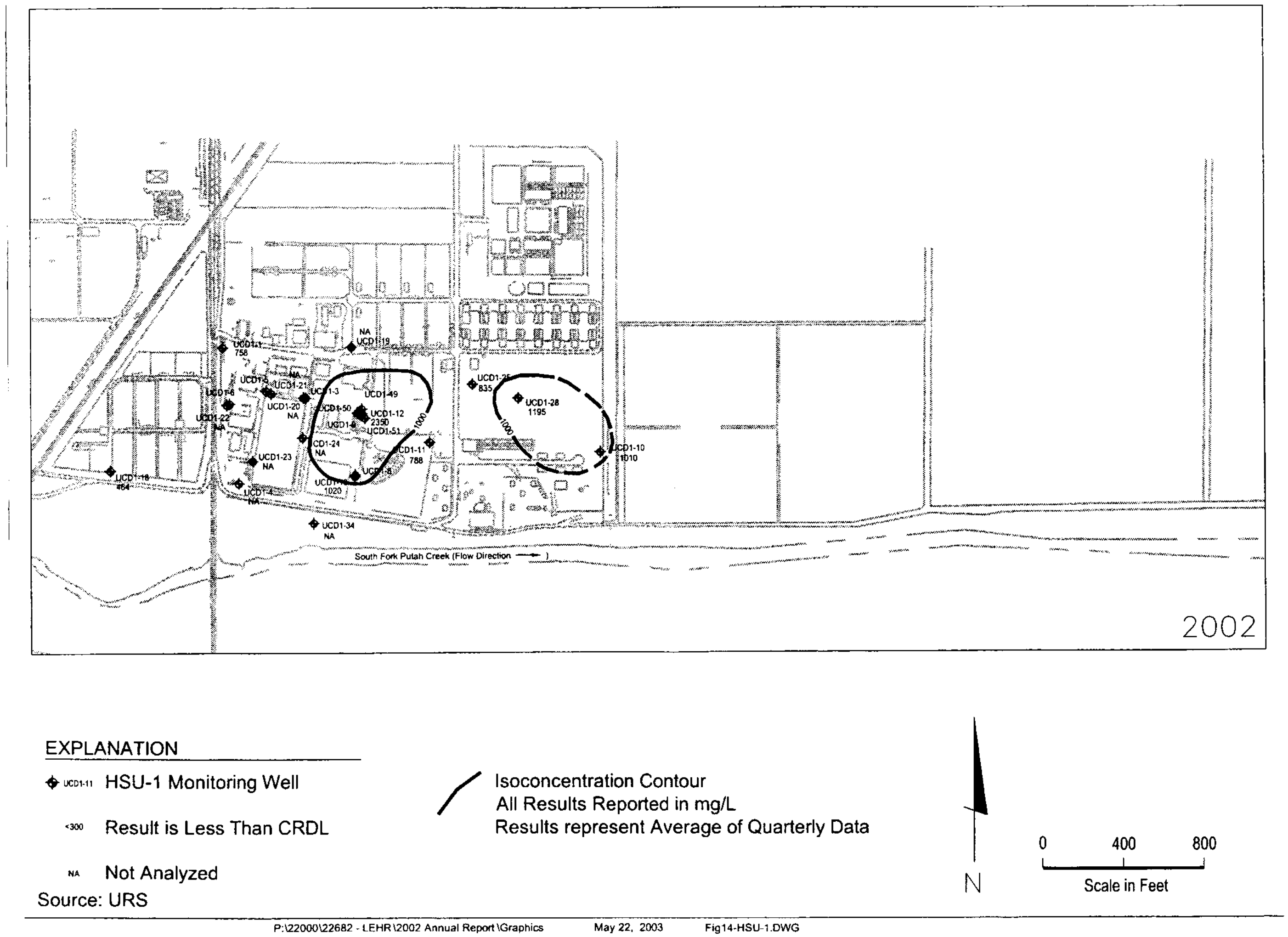
NOTE: BASE MAP FROM BROWN AND CALDWELL

TDS ISOCONCENTRATION CONTOURS IN HSU-1, 2001



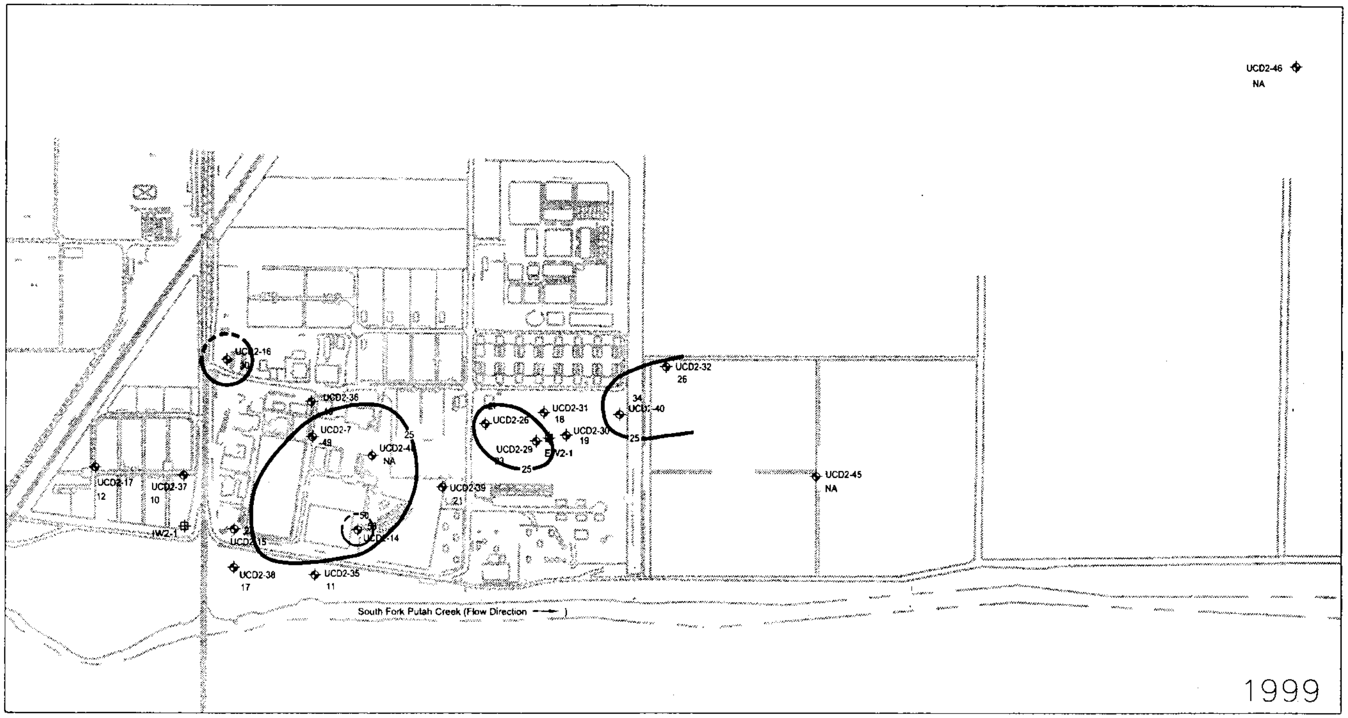
NOTE: BASE MAP FROM BROWN AND CALDWELL

TDS ISOCONCENTRATION CONTOURS IN HSU-1, 2002



NOTE: BASE MAP FROM BROWN AND CALDWELL

CHROMIUM ISOCONCENTRATION CONTOURS IN HSU-2, 1999



EXPLANATION

- UCD2-17 HSU-2 Monitoring Well
- EW2-1 HSU-2 Extraction Well
- IW2-1 HSU-2 Injection Well

Source: URS

- <300 Result is Less Than CRDL
- NA Not Analyzed
- Isoconcentration Contour, All Results Reported in ug/L
  Results represent Average of Quarterly Data

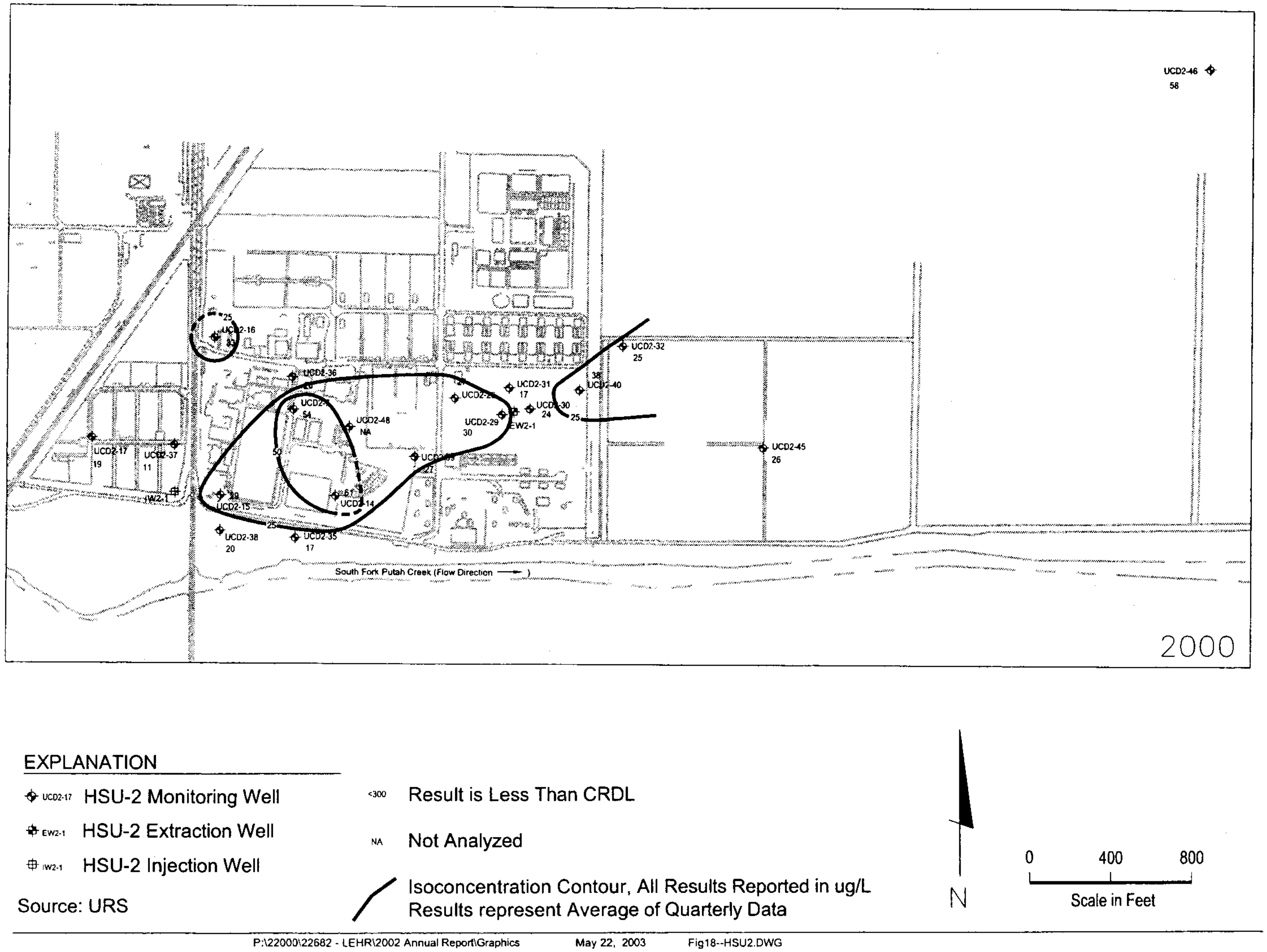
N

0 400 800
Scale in Feet

P:\22000\22682 - LEHR\2002 Annual Report\Graphics May 22, 2003 Fig18--HSU2.DWG

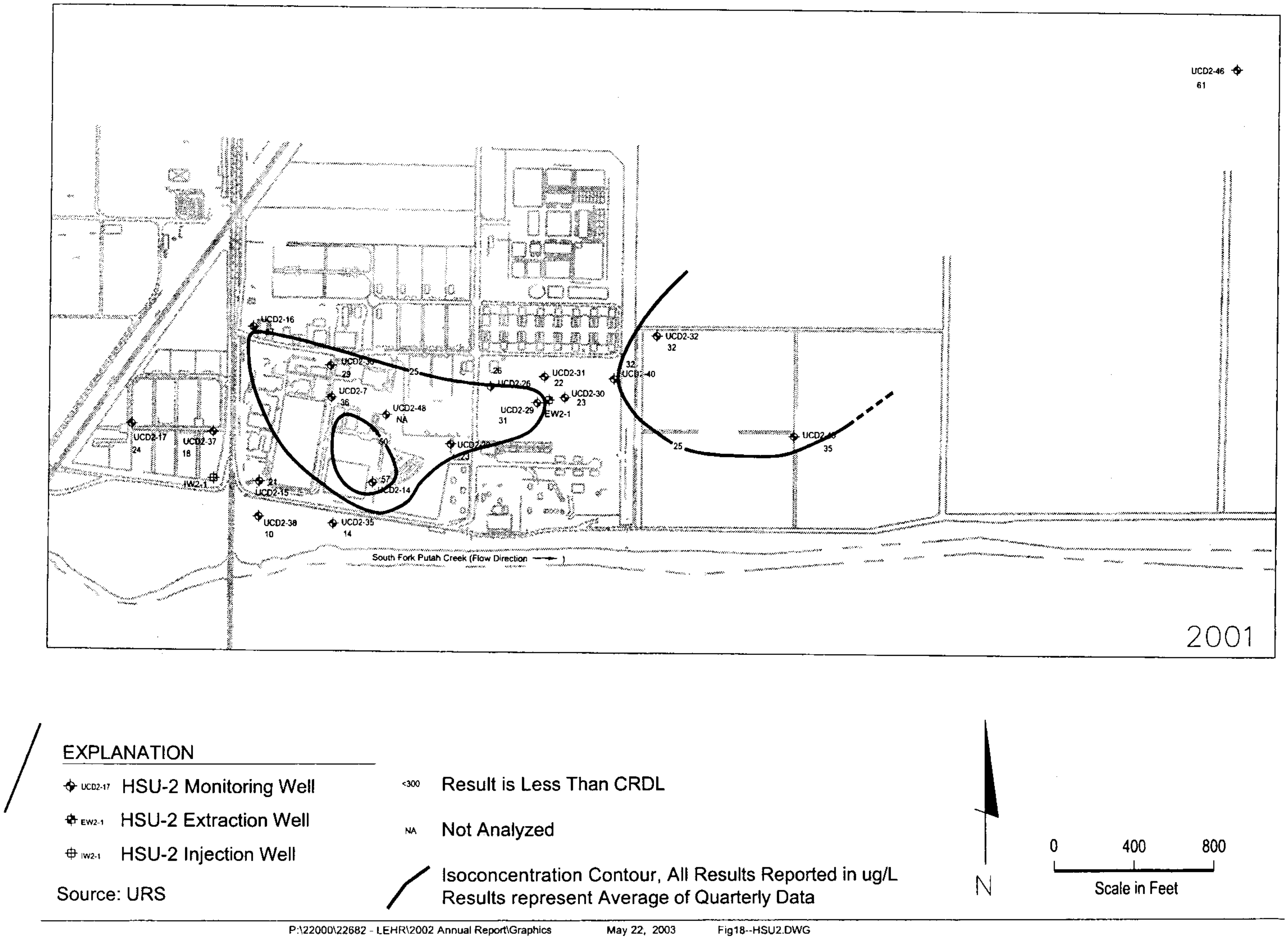
NOTE: BASE MAP FROM BROWN AND CALDWELL

CHROMIUM ISOCONCENTRATION CONTOURS IN HSU-2, 2000



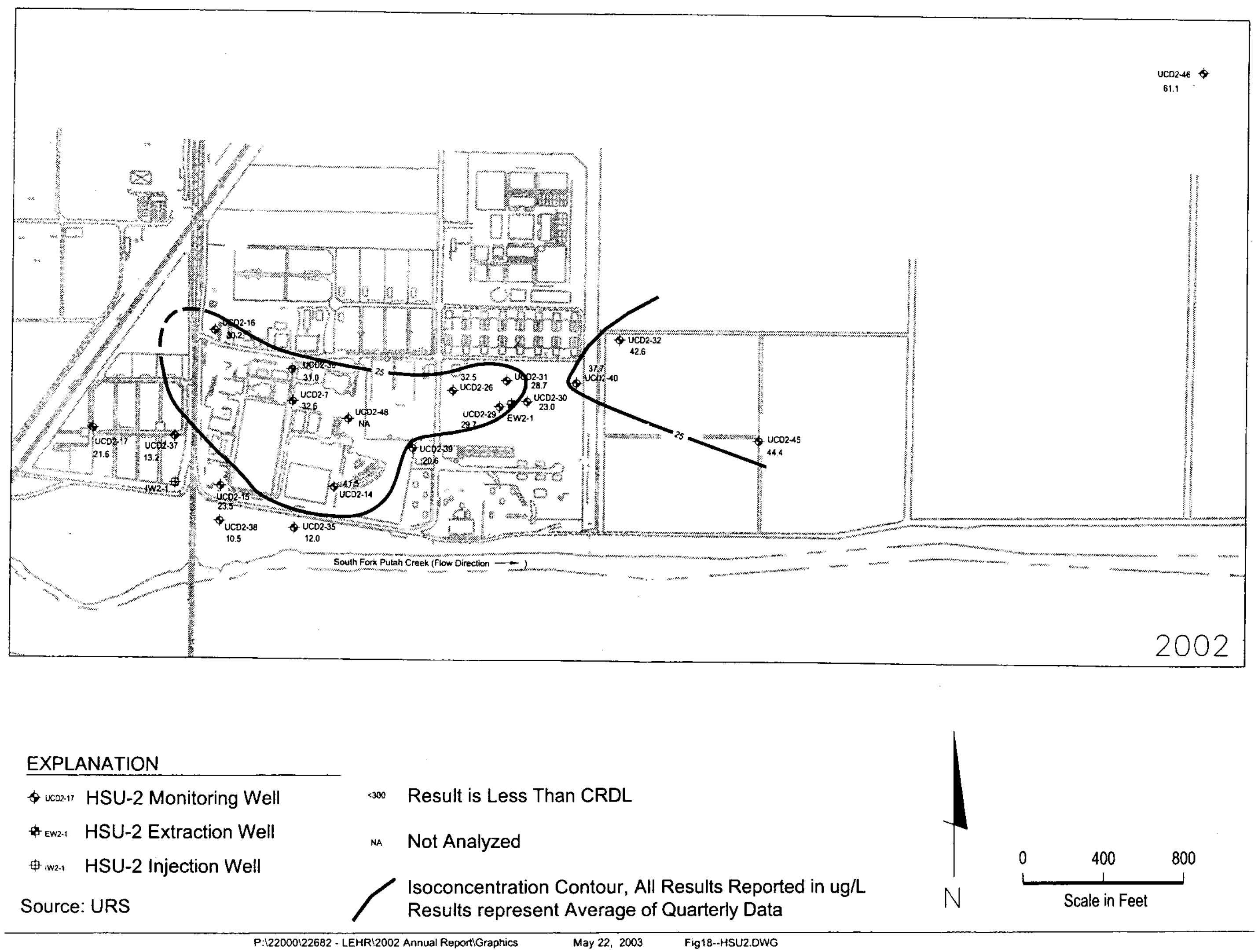
NOTE: BASE MAP FROM BROWN AND CALDWELL

CHROMIUM ISOCONCENTRATION CONTOURS IN HSU-2, 2001



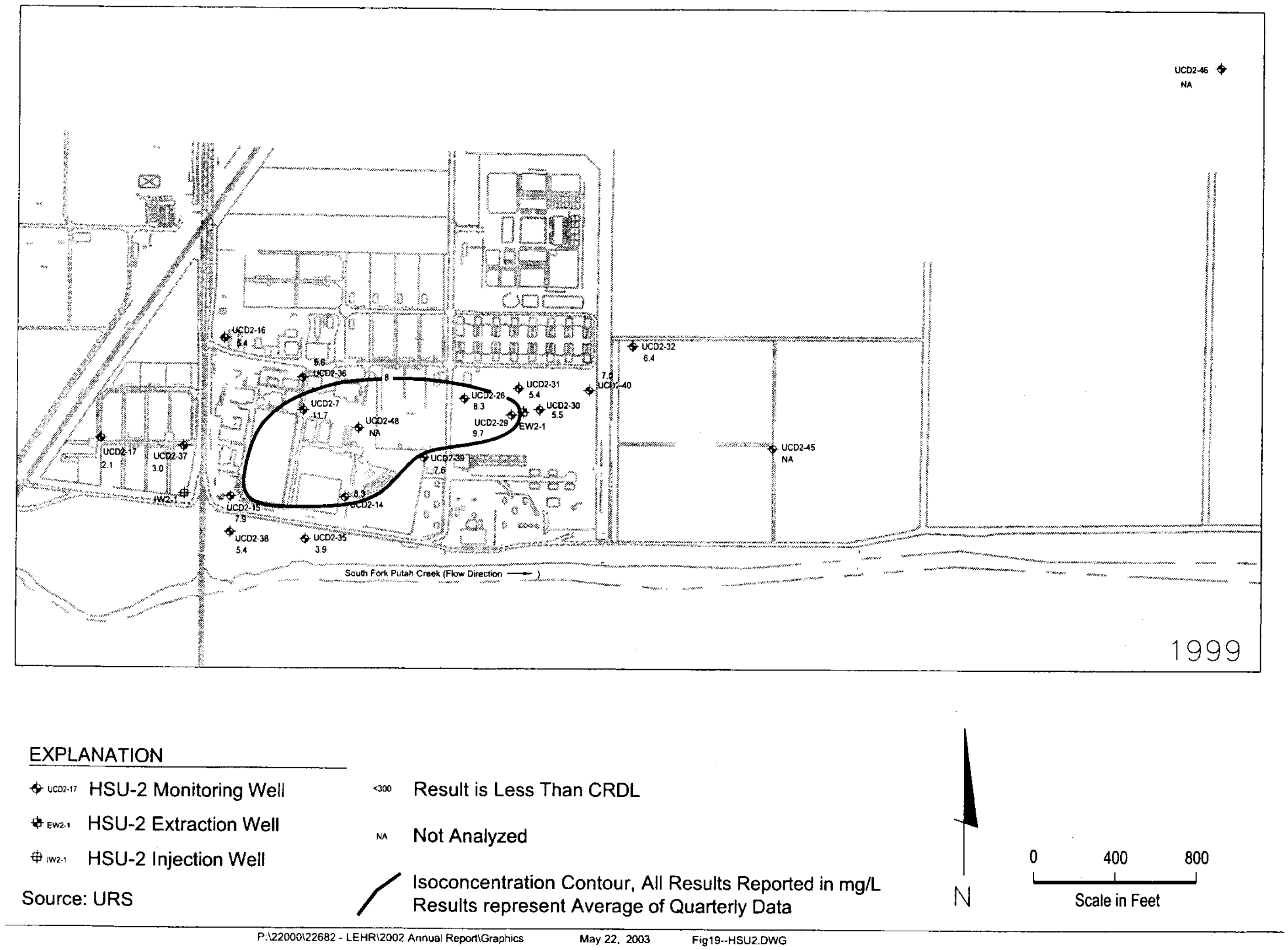
NOTE: BASE MAP FROM BROWN AND CALDWELL

CHROMIUM ISOCONCENTRATION CONTOURS IN HSU-2, 2002



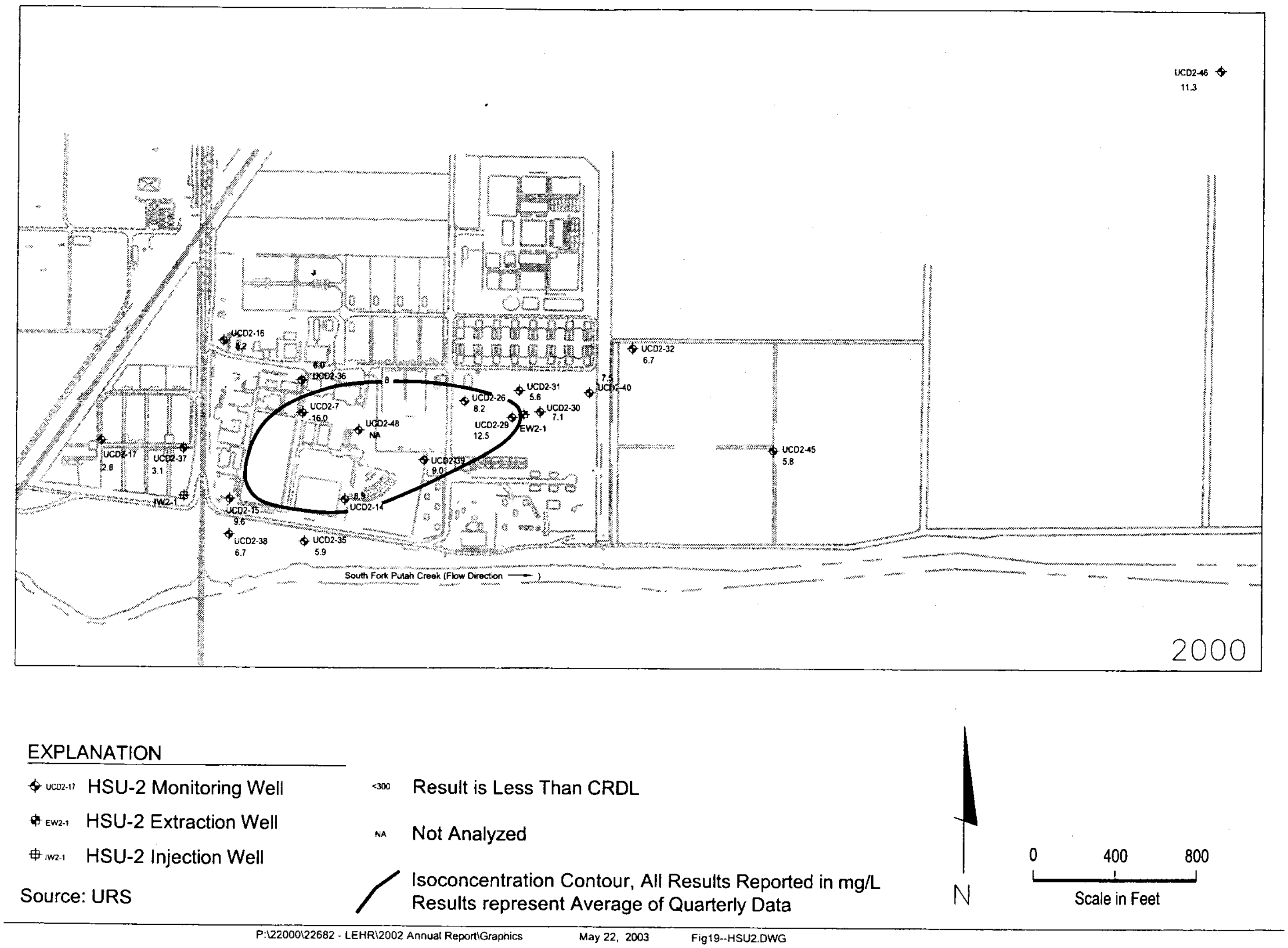
NOTE: BASE MAP FROM BROWN AND CALDWELL

NITRATE AS N ISOCONCENTRATION CONTOURS IN HSU-2, 1999



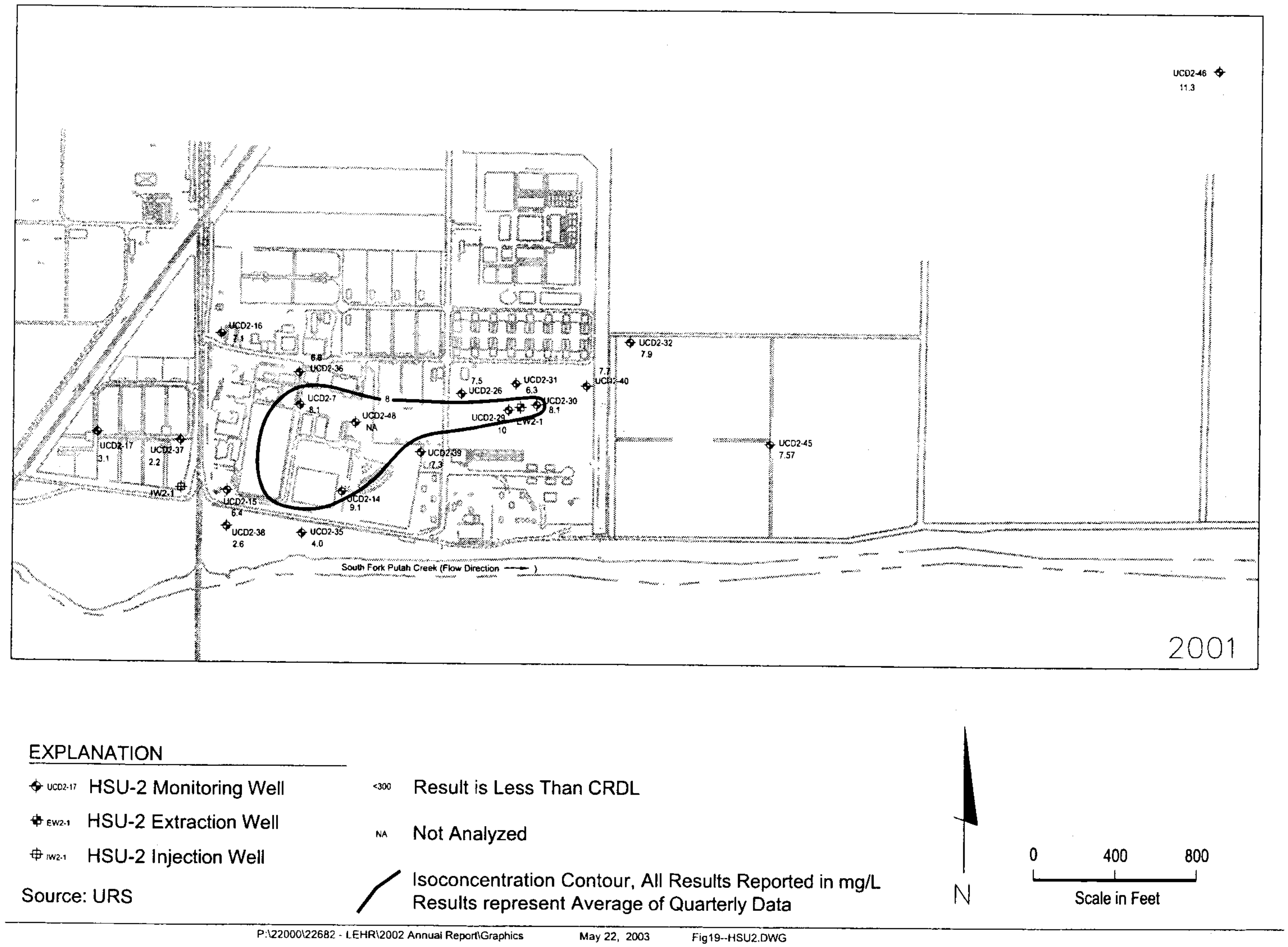
NOTE: BASE MAP FROM BROWN AND CALDWELL

NITRATE AS N ISOCONCENTRATION CONTOURS IN HSU-2, 2000



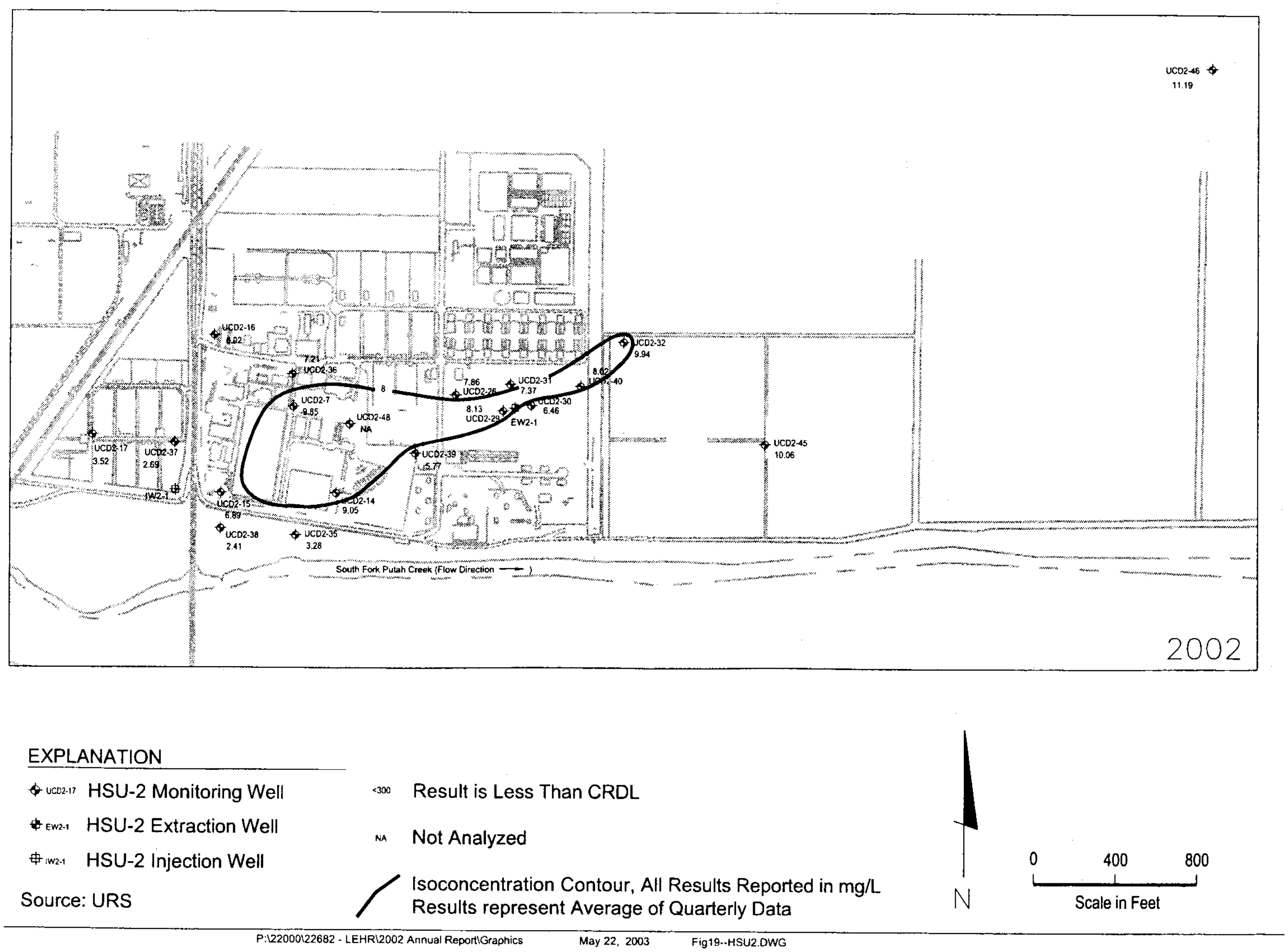
NOTE: BASE MAP FROM BROWN AND CALDWELL

NITRATE AS N ISOCONCENTRATION CONTOURS IN HSU-2, 2001



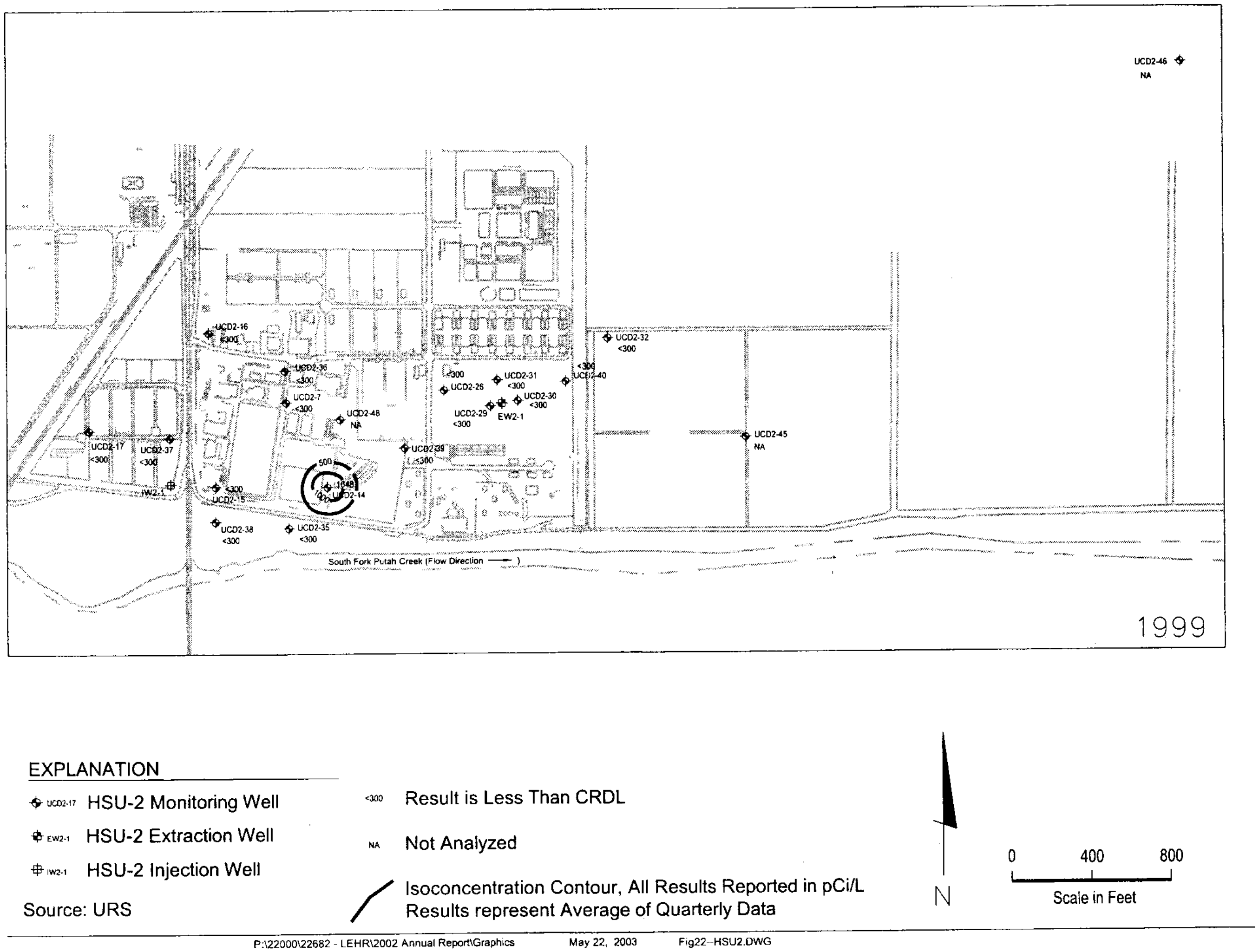
NOTE: BASE MAP FROM BROWN AND CALDWELL

NITRATE AS N ISOCONCENTRATION CONTOURS IN HSU-2, 2002



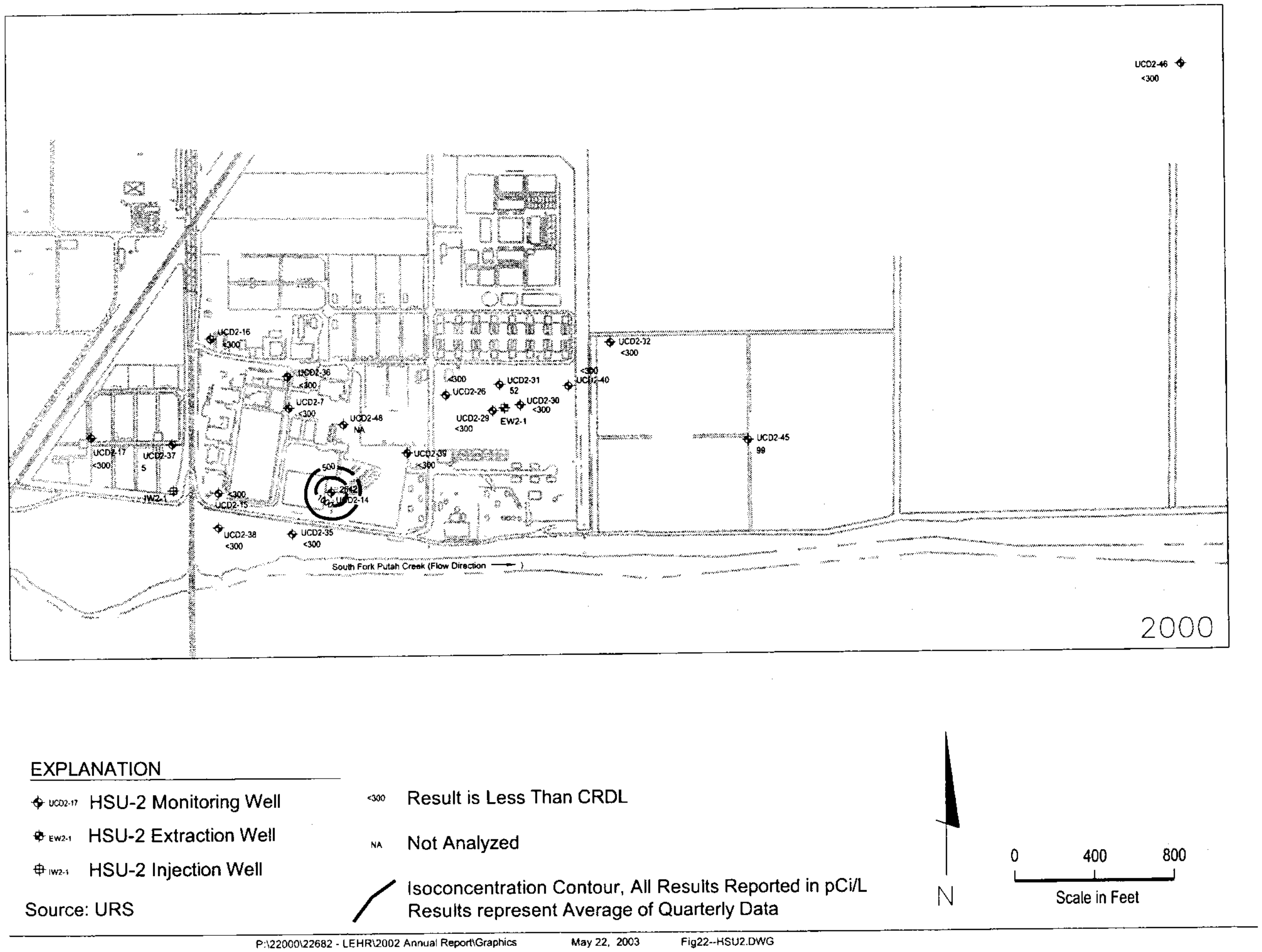
NOTE: BASE MAP FROM BROWN AND CALDWELL

TRITIUM ISOCONCENTRATION CONTOURS IN HSU-2, 1999



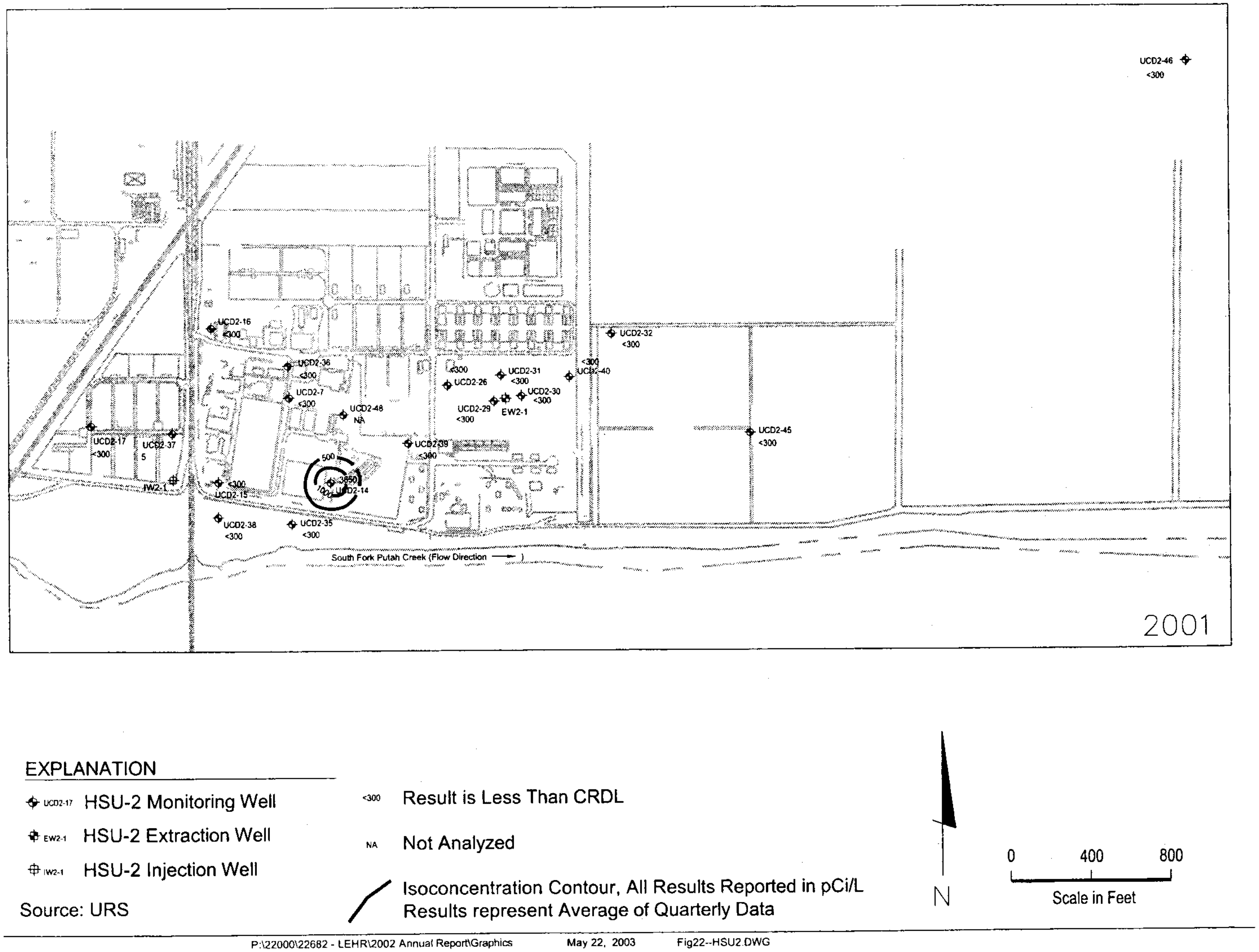
NOTE: BASE MAP FROM BROWN AND CALDWELL

TRITIUM ISOCONCENTRATION CONTOURS IN HSU-2, 2000



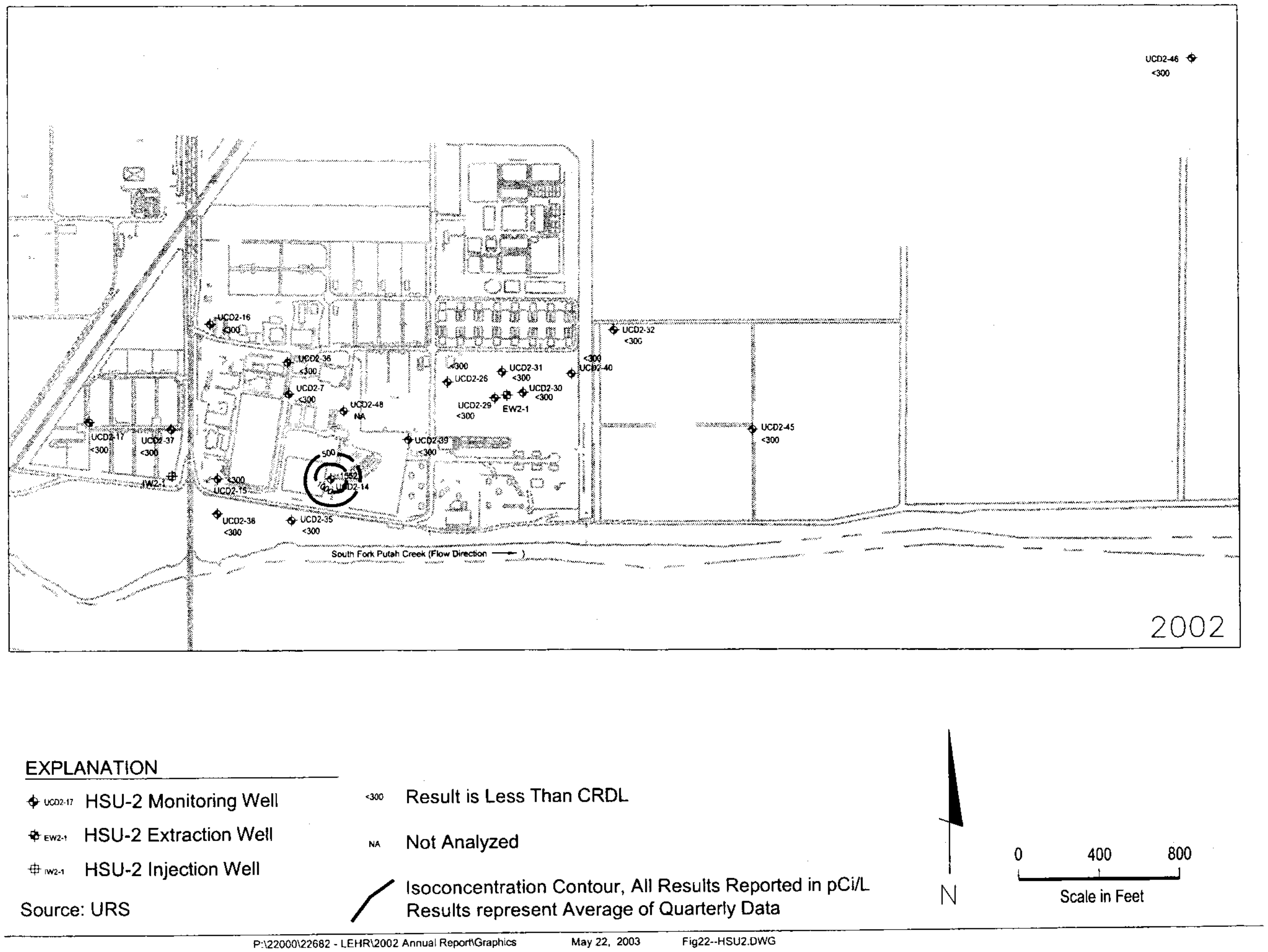
NOTE: BASE MAP FROM BROWN AND CALDWELL

TRITIUM ISOCONCENTRATION CONTOURS IN HSU-2, 2001



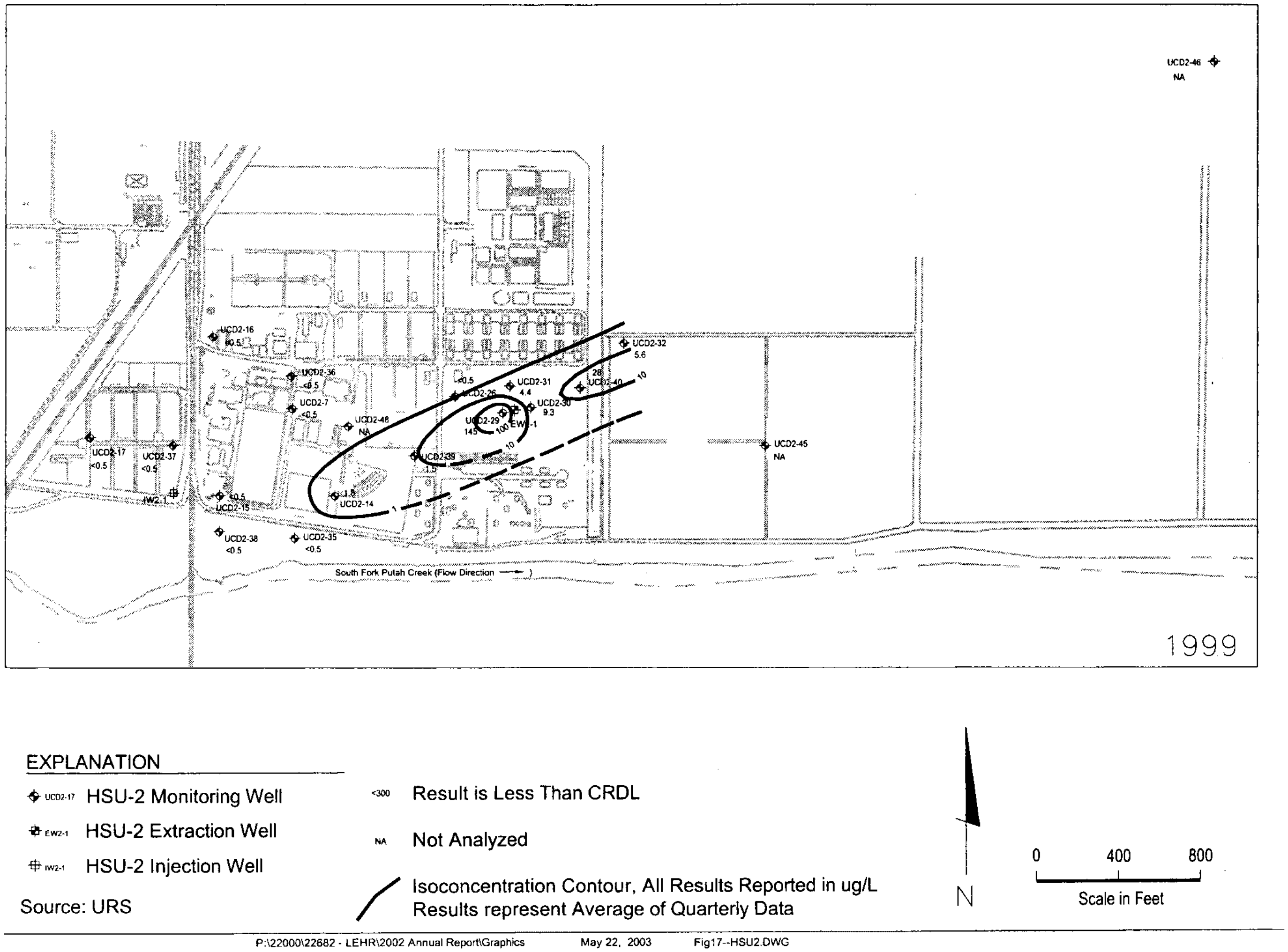
NOTE: BASE MAP FROM BROWN AND CALDWELL

TRITIUM ISOCONCENTRATION CONTOURS IN HSU-2, 2002



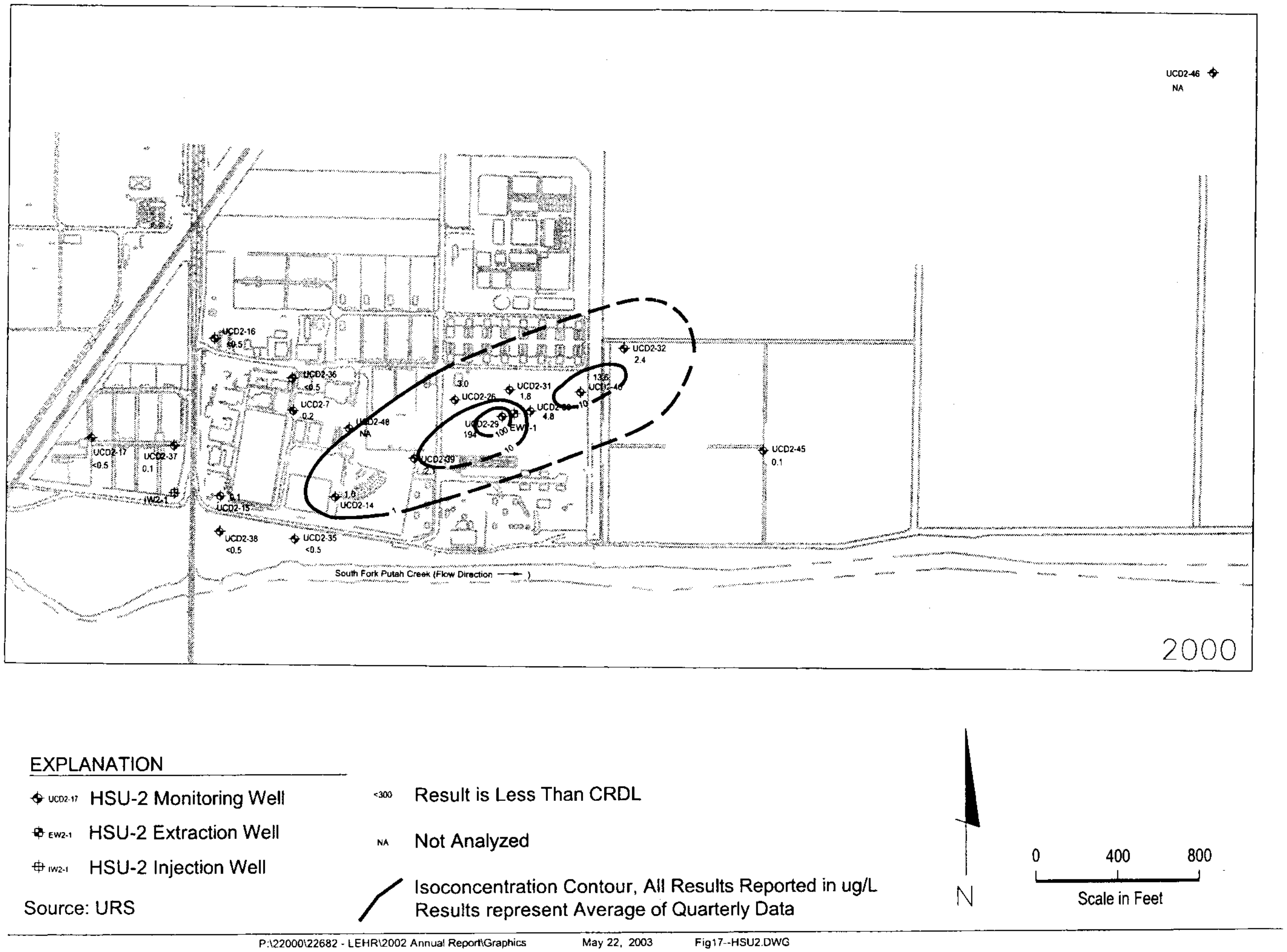
NOTE: BASE MAP FROM BROWN AND CALDWELL

CARBON-14 ISOCONCENTRATION CONTOURS IN HSU-2, 1999



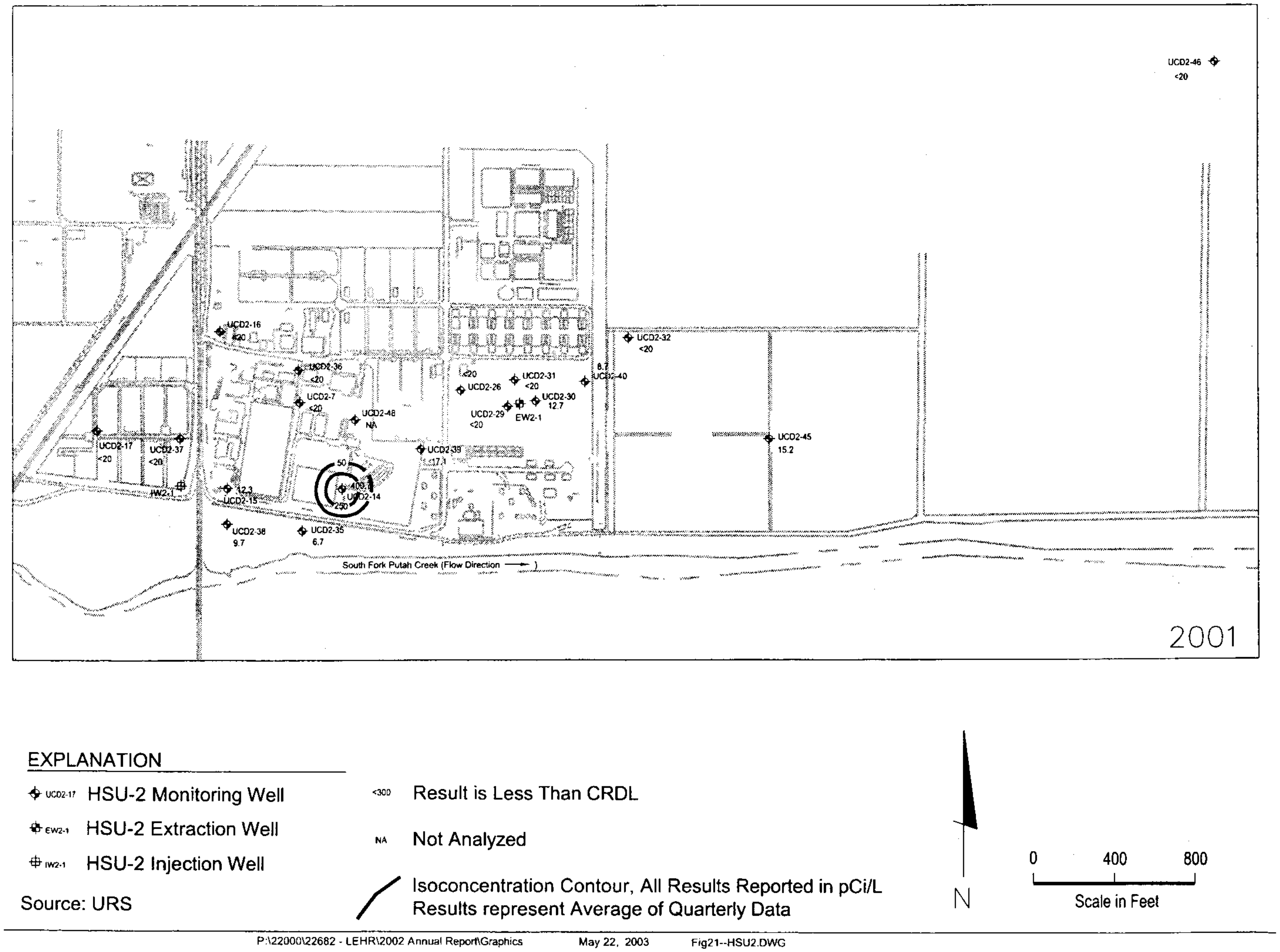
NOTE: BASE MAP FROM BROWN AND CALDWELL

CARBON-14 ISOCONCENTRATION CONTOURS IN HSU-2, 2000



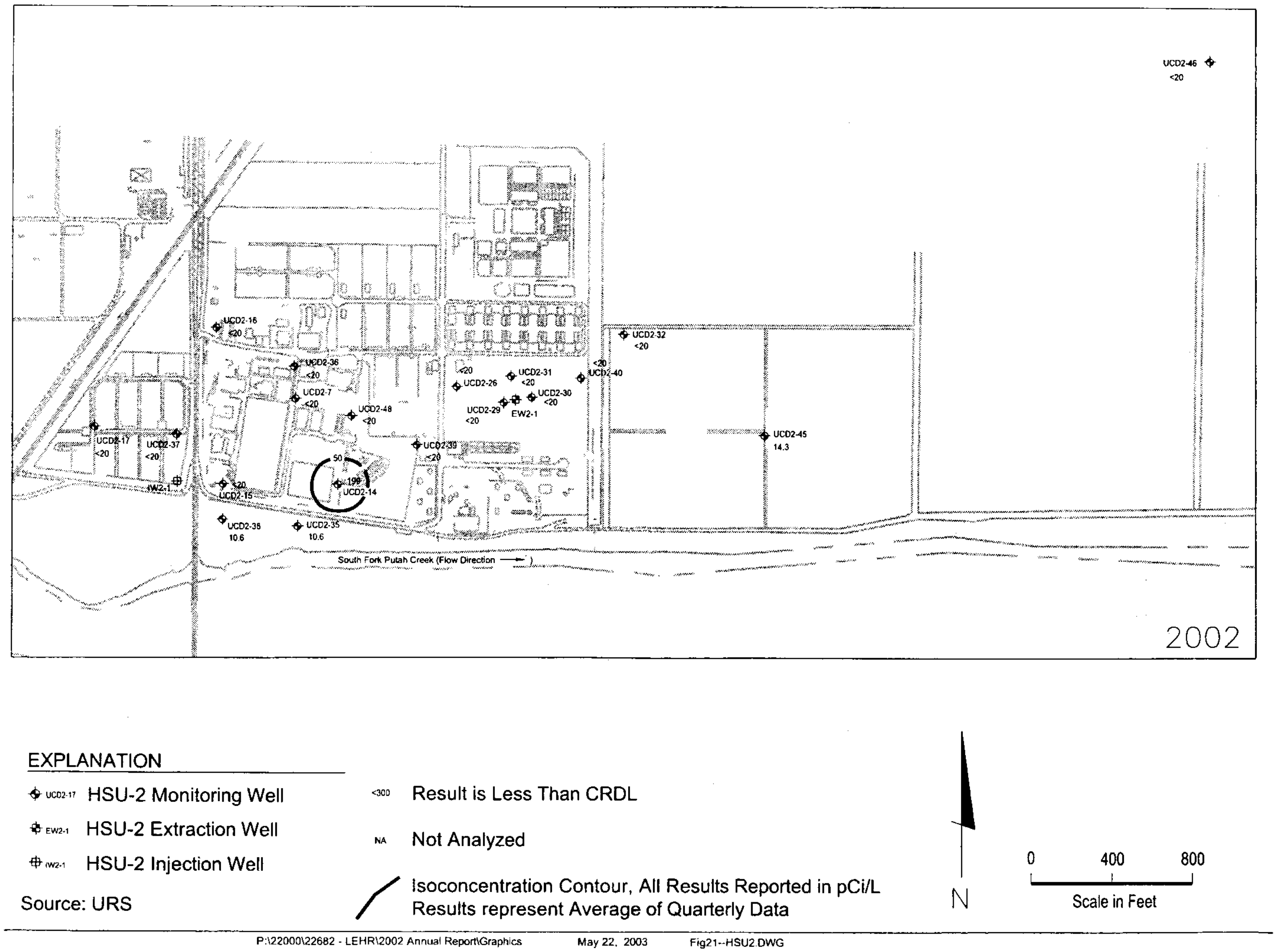
NOTE: BASE MAP FROM BROWN AND CALDWELL

CARBON-14 ISOCONCENTRATION CONTOURS IN HSU-2, 2001



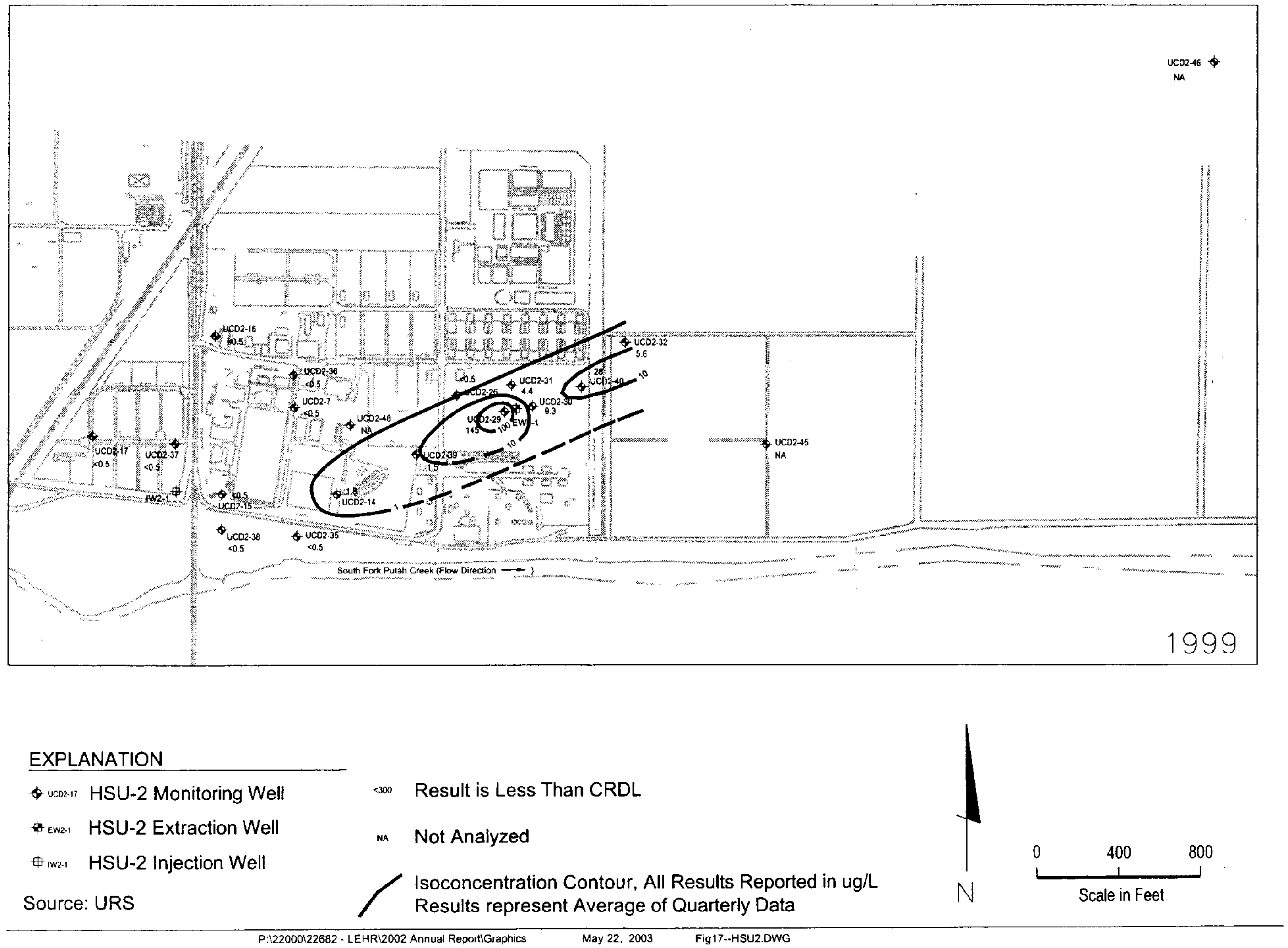
NOTE: BASE MAP FROM BROWN AND CALDWELL

CARBON-14 ISOCONCENTRATION CONTOURS IN HSU-2, 2002



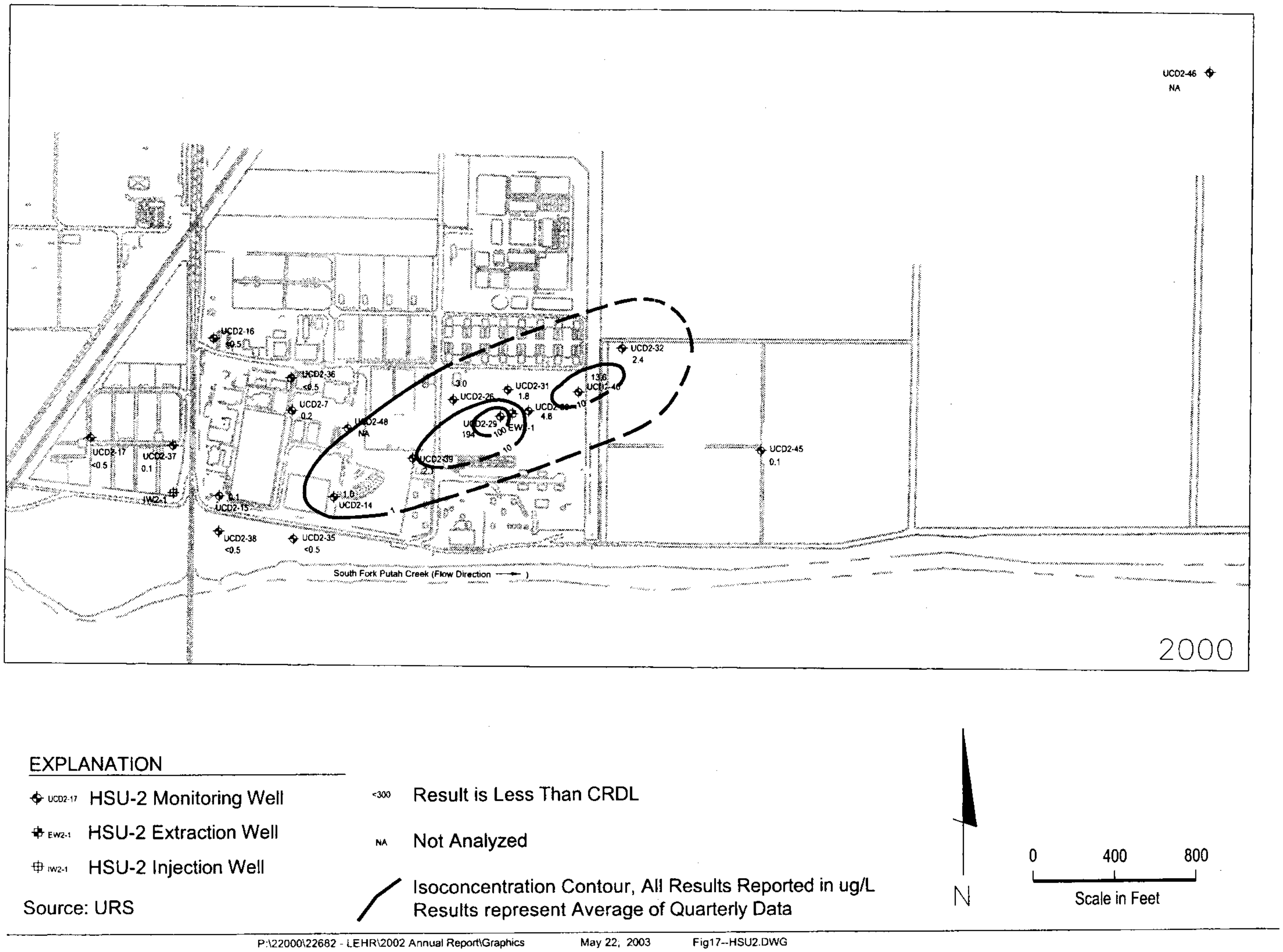
NOTE: BASE MAP FROM BROWN AND CALDWELL

CHLOROFORM ISOCONCENTRATION CONTOURS IN HSU-2, 1999



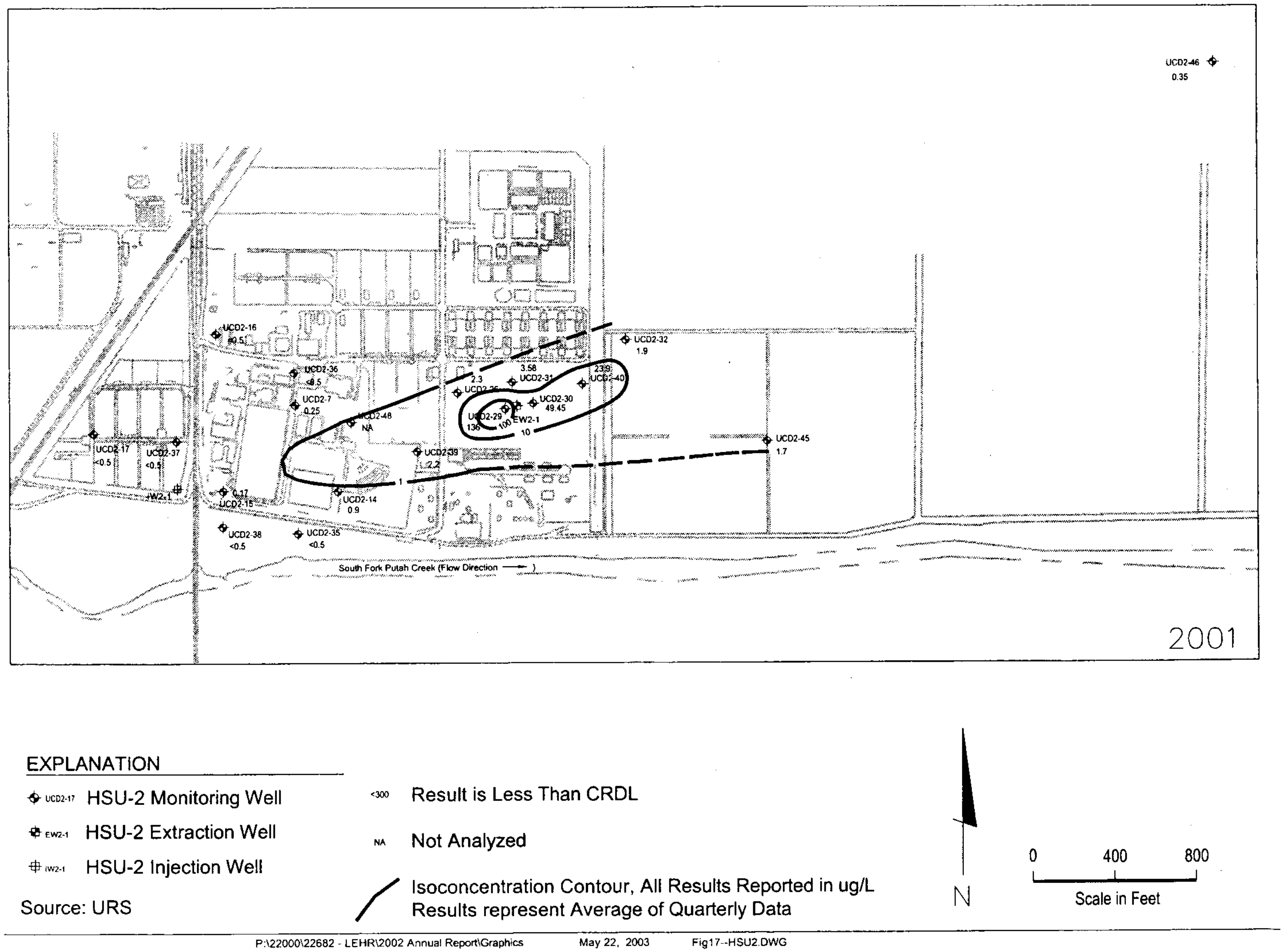
NOTE: BASE MAP FROM BROWN AND CALDWELL

CHLOROFORM ISOCONCENTRATION CONTOURS IN HSU-2, 2000



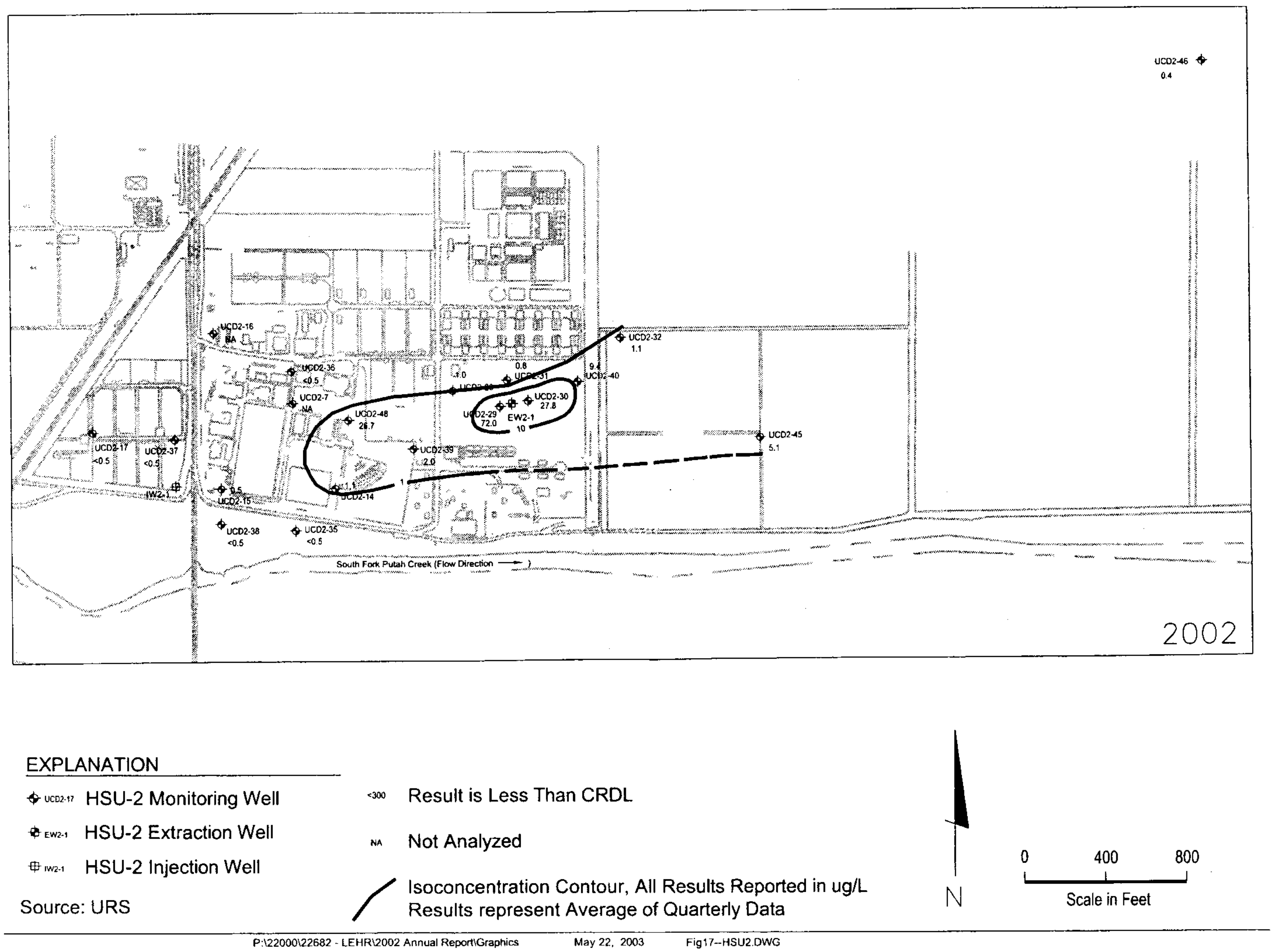
NOTE: BASE MAP FROM BROWN AND CALDWELL

CHLOROFORM ISOCONCENTRATION CONTOURS IN HSU-2, 2001



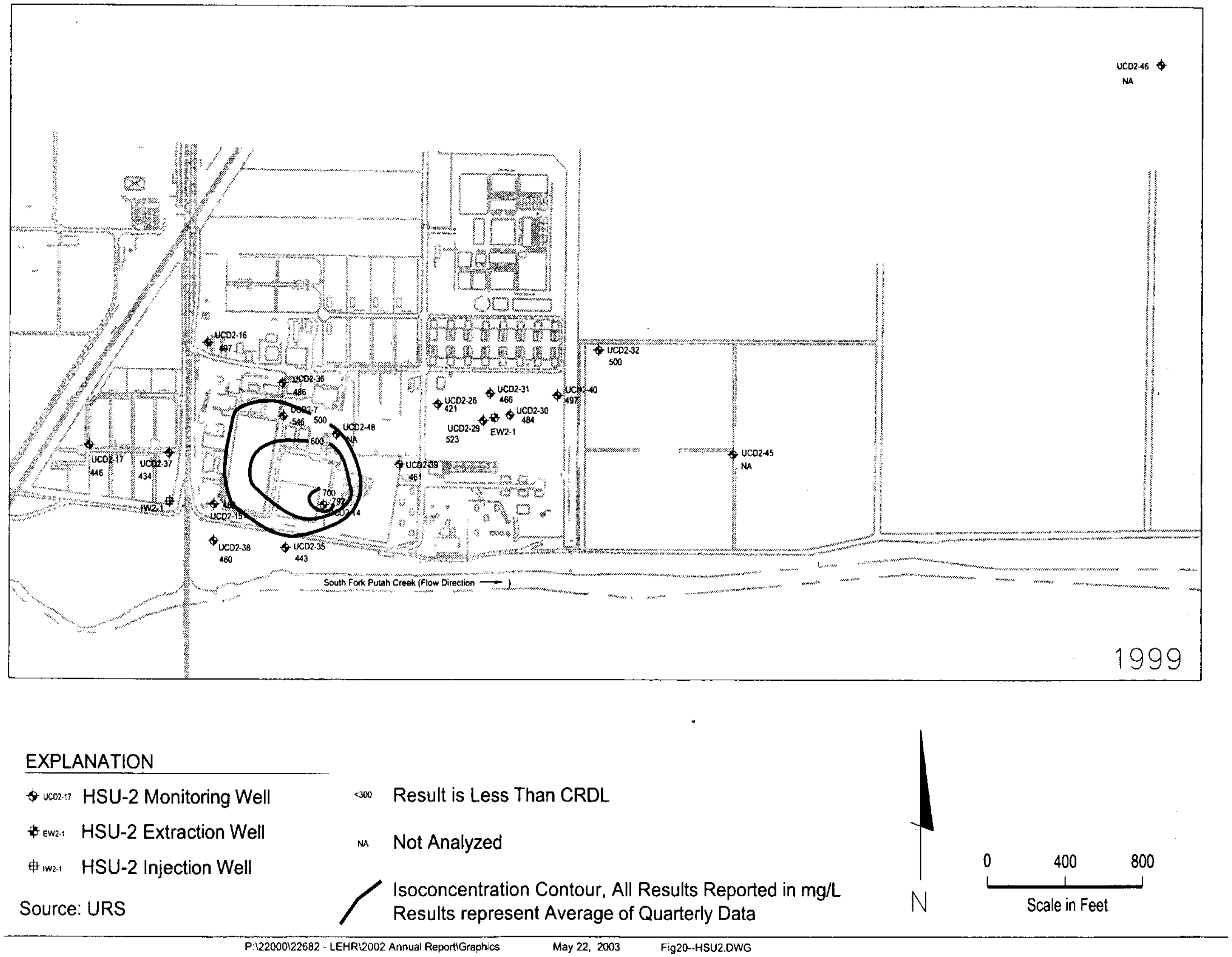
NOTE: BASE MAP FROM BROWN AND CALDWELL

CHLOROFORM ISOCONCENTRATION CONTOURS IN HSU-2, 2002



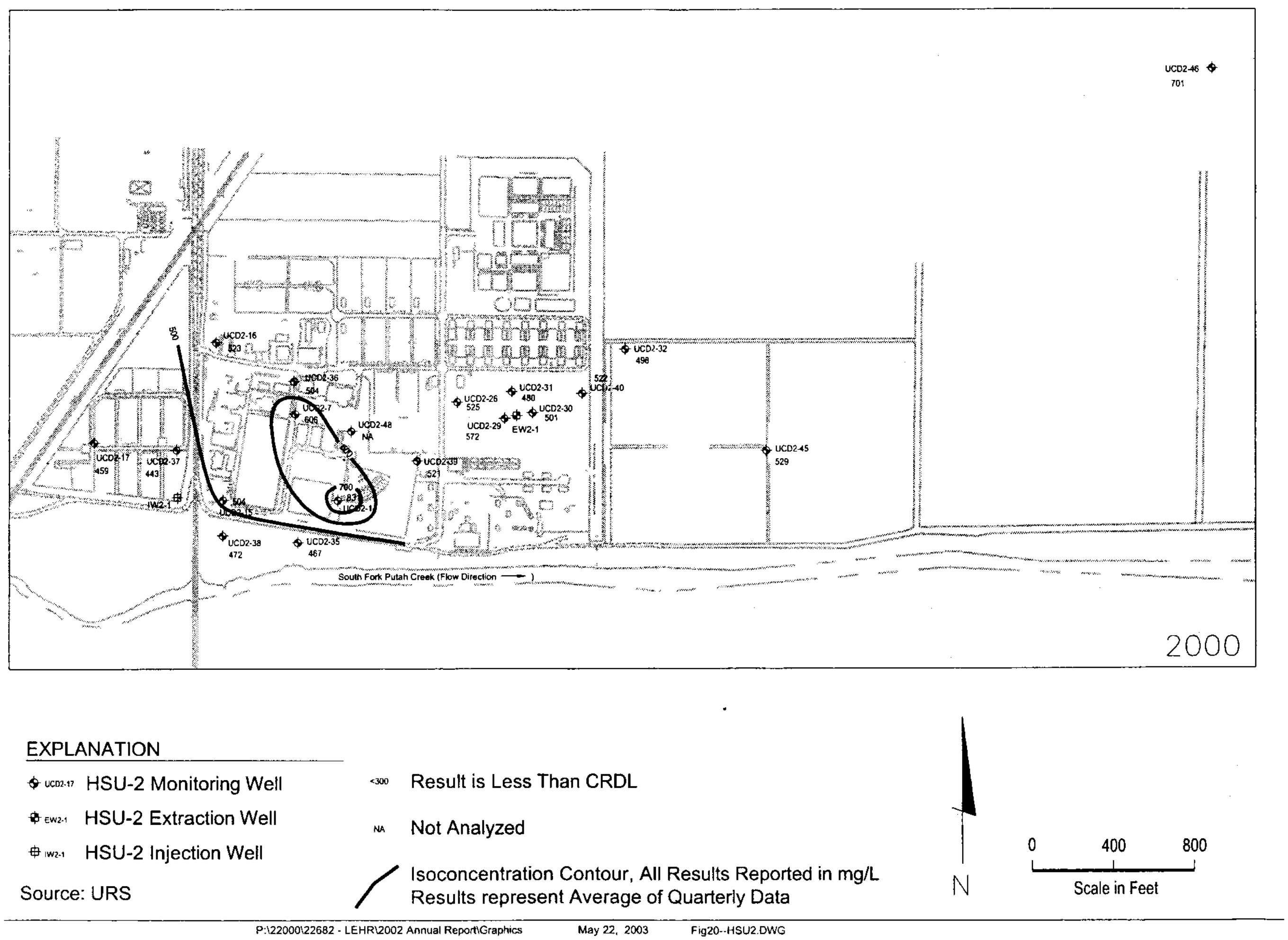
NOTE: BASE MAP FROM BROWN AND CALDWELL

TDS ISOCONCENTRATION CONTOURS IN HSU-2, 1999



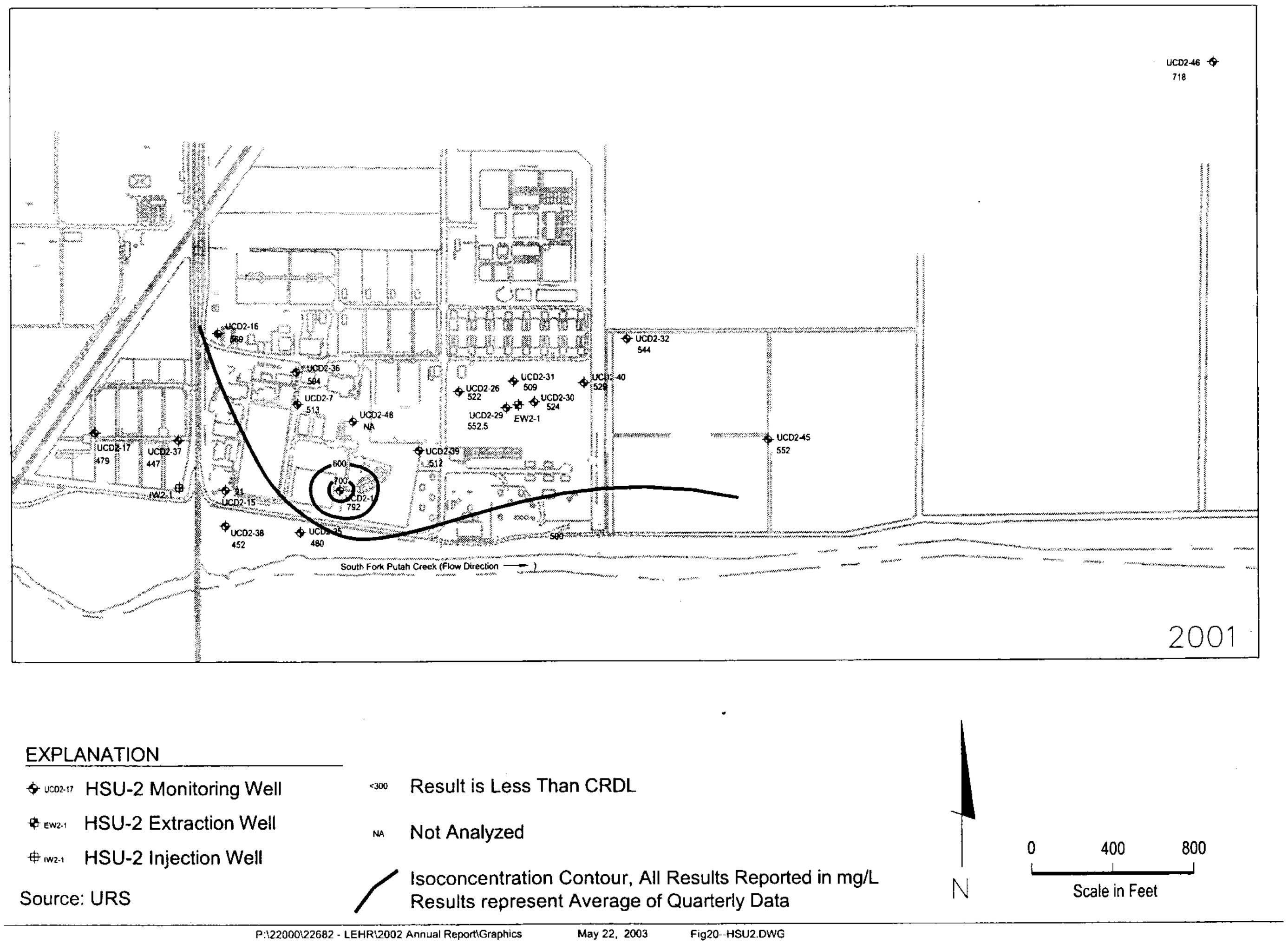
NOTE: BASE MAP FROM BROWN AND CALDWELL

TDS ISOCONCENTRATION CONTOURS IN HSU-2, 2000



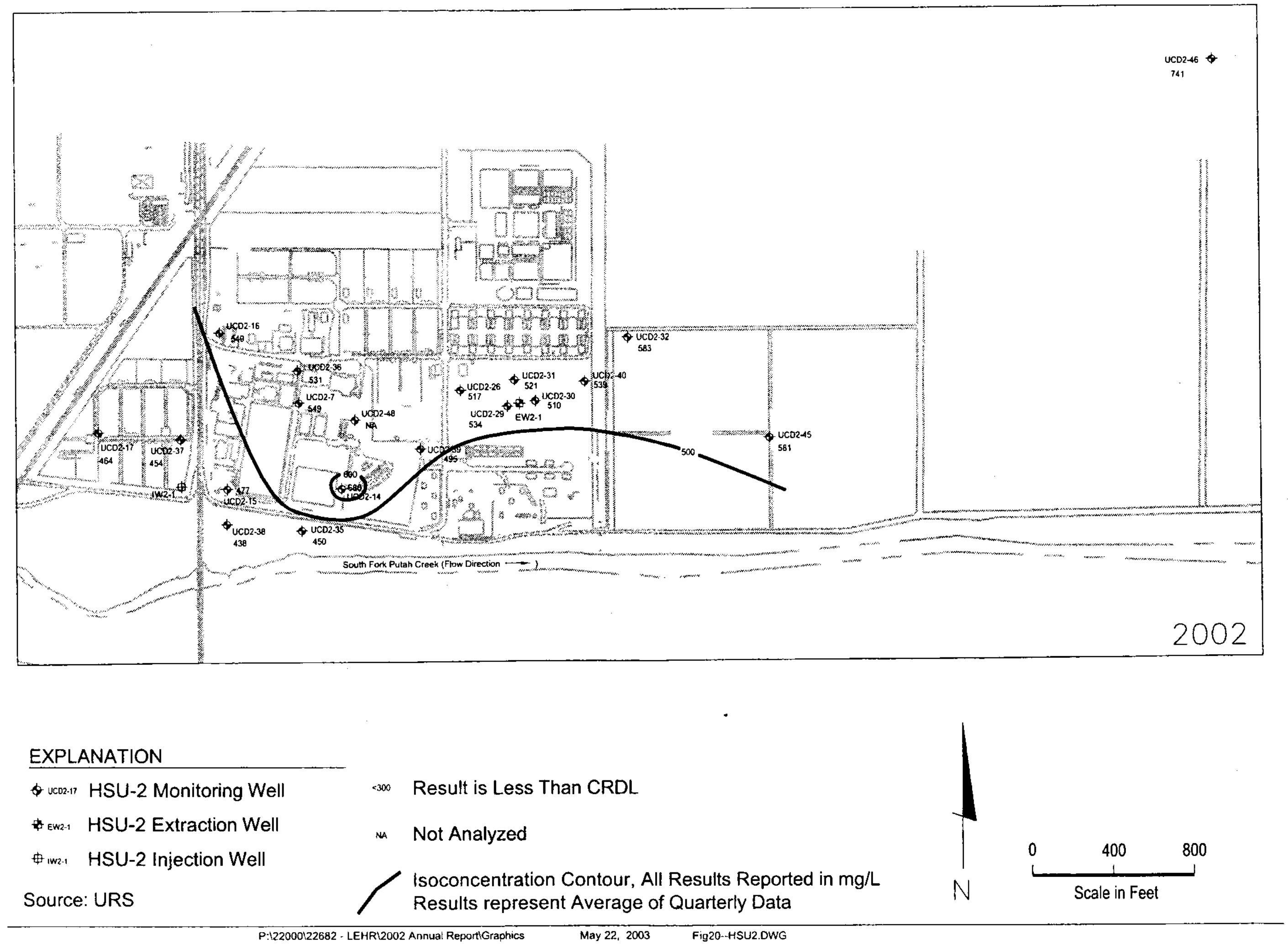
NOTE: BASE MAP FROM BROWN AND CALDWELL

TDS ISOCONCENTRATION CONTOURS IN HSU-2, 2001



NOTE: BASE MAP FROM BROWN AND CALDWELL

TDS ISOCONCENTRATION CONTOURS IN HSU-2, 2002



NOTE: BASE MAP FROM BROWN AND CALDWELL